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ARCTIC OIL SPILL RESPONSE GUIDE FOR THE ALASKAN BEAUFORT SEA

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16. Abstract

This document describes equipment, techniques and logistics for responding to oil spills in the Alaskan Beaufort Sea. It is designed to serve as a planning guide which will help the U.S. Coast Guard On-Scene Coordinator indentify the steps and priorities for responding to major oil spills or oil well blowouts associated with petroleum activity off the northern coast of Alaska. Along with providing critical insight for developing an oil spill response strategy, this document discusses environmental factors which can contribute to the success or failure of an oil spill cleanup operation in arctic waters. Additionally, it provides a detailed description of the oil spill cleanup equipment in Alaska and outlines manpower requirements for its deployment and operation.

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METRIC CONVERSION FACTORS

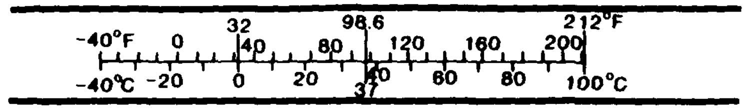
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (WEIGHT)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (EXACT)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures. Price $2.25. SD Catalog No. C13.10.286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (WEIGHT)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	0.125	cups	c
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (EXACT)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



PREFACE

This guide has been developed to familiarize the U.S. Coast Guard On-Scene Coordinator (OSC) with the equipment, techniques and logistics for responding to oil spills in the Alaskan Beaufort Sea. By reading this handbook, the OSC will gain valuable insight for response priorities and identifying limitations which could hinder or prevent effective oil spill cleanup.

Although this guide describes the resources which are currently located in Alaska for oil spill response, it is not intended to be a step by step plan for every conceivable spill situation. Rather, this guide is to provide information which will enable the OSC to evaluate spills and identify countermeasures which will minimize their impact on the environment.

Any trade names, commercial products or commercial firms cited in this guide are not endorsed by the U.S. Coast Guard. Since there has never been a major oil spill in the Alaskan Beaufort Sea, it is hereby acknowledged that the response techniques presented in this guide are not necessarily based on proven field performance.

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1.0 INTRODUCTION AND SUMMARY

1.1 Purpose

This planning guide has been prepared to help the On-Scene Coordinator (OSC) write local contingency plans and implement response operations for oil spills in the Alaskan Beaufort Sea. It contains information which will enable the OSC to determine if the responsible party is putting forth sufficient effort to mitigate the environmental impact of oil spills which result from its operation. This planning guide is also designed to serve as a reference which will assist the OSC in evaluating oil spill contingency plans for petroleum related activities in Arctic waters.

This document goes several steps beyond most oil spill contingency plans. Along with describing the state-of-the-art for oil spill response in the Arctic, it provides step-by-step guidelines for implementing appropriate oil spill countermeasures in the Alaskan Beaufort Sea. In addition to highlighting the positive aspects of existing cleanup equipment and techniques, it also identifies limitations and deficiencies inherent in Arctic oil spill response technology. As a result, it enables the OSC to carefully evaluate various oil spill response techniques and avoid being mislead by results which were obtained under controlled test conditions.

This document will also familiarize the OSC and Regional Response Team with the equipment and support services in Alaska for spill response in the Beaufort Sea.

1.2 Background Information

In 1968 the nation's largest oil field was discovered at Prudhoe Bay, Alaska. This initiated an Arctic oil rush which resulted in the discovery of several other major fields on the North Slope of Alaska (Figure 1.1). During 1980, the search for oil moved offshore into the Alaskan Beaufort Sea. In 1984 several oil companies announced significant offshore discoveries. By mid-1988, Endicott will come on-line as the nation's first petroleum production facility in the Beaufort Sea. Based on seismic data, industry energy analysts believe that the Beaufort Sea could hold the largest domestic reservoirs of hydrocarbons in the United States. Therefore, despite declining oil revenues which were experienced in the mid-1980's, it is likely that oil and gas exploration will continue in the Beaufort Sea for some time in the future.

Due to the enormous level of petroleum exploration and development in the Beaufort Sea region, significant steps have been taken by industry to develop adequate oil spill response capability. For example, oil companies holding leases in this region

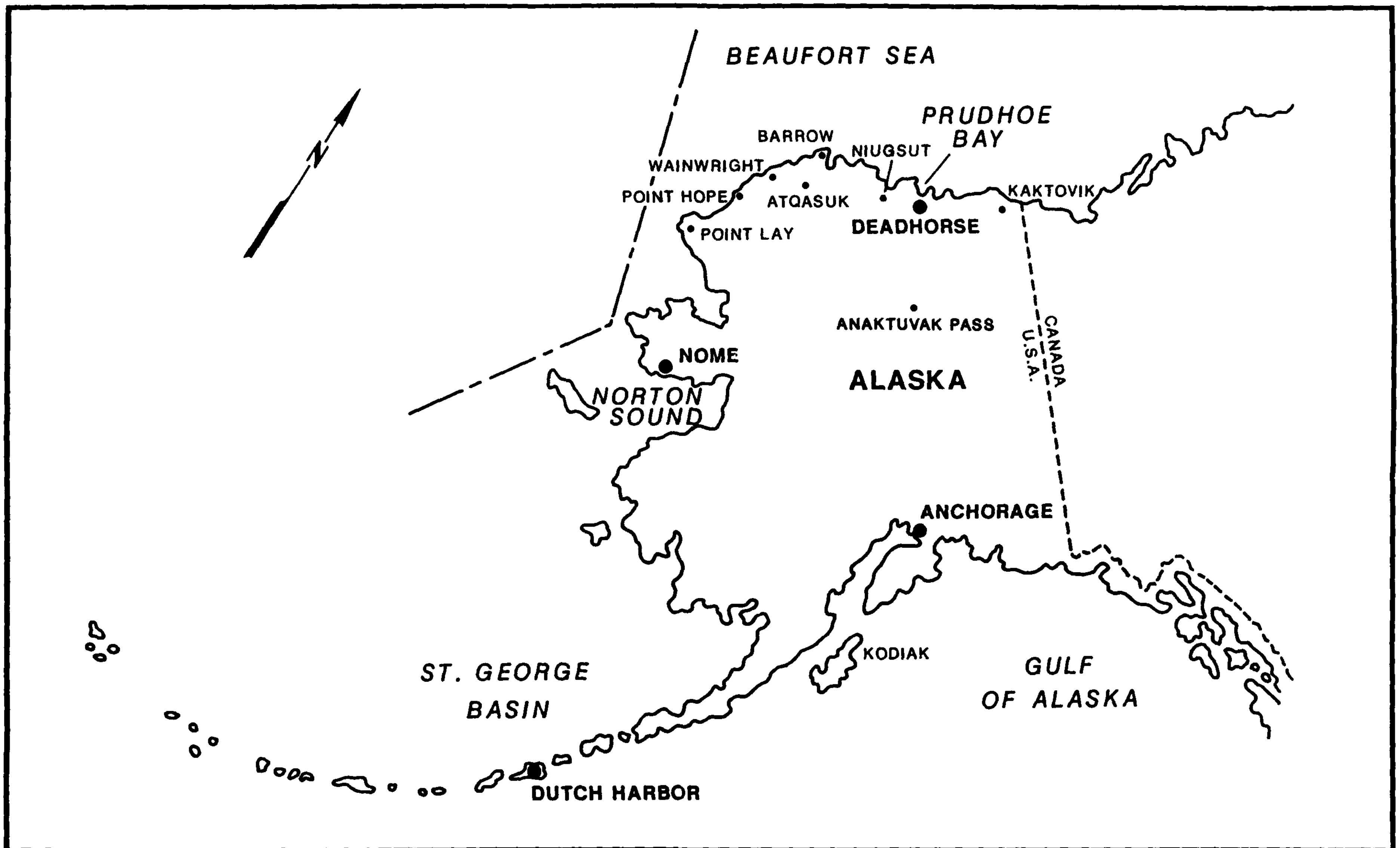


Figure 1.1

ALASKA

have formed the Alaskan Beaufort Sea Oil Spill Response Body (ABSORB). Through ABSORB they have stockpiled over 5 million dollars worth of oil spill response equipment at Prudhoe Bay. Additionally, they have supported over 3 million dollars worth of Arctic oil spill research and development.

Despite this tremendous effort, a regional contingency plan which outlines the steps for responding to oil spills occurring anywhere in the Beaufort Sea does not exist. The reasons for this are as follows:

- o Most industry oil spill contingency plans are prepared for specific exploration or development sites in the Beaufort Sea.

- o Many industry oil spill contingency plans are designed to satisfy specific regulatory requirements and do not provide step-by-step guidelines for implementing an oil spill response operation.

This planning guide resolves these limitations by identifying response elements and providing response guidelines for oil spills which could occur during any season in the Alaskan Beaufort Sea, regardless of location.

This information will help the OSC to fulfill his responsibilities as established by the National Oil and Hazardous Substance Pollution Contingency Plan.

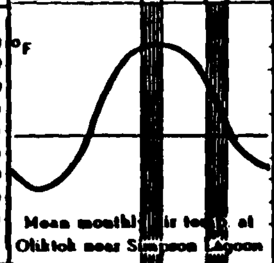
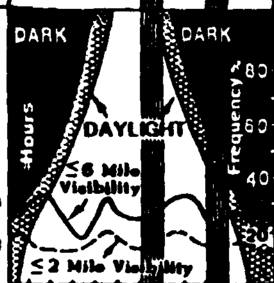
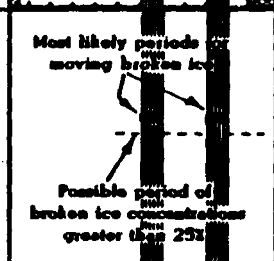
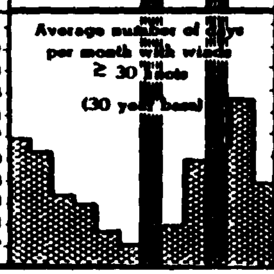
1.3 Environmental Data

Weather conditions for the Beaufort Sea region include low temperatures, little precipitation, high winds, and periods of dense fog. From October through May most of the Alaska Beaufort Sea is covered by solid ice. During June, breakup begins and varying degrees of broken ice exist through early August. From early August to early September open water exists in most areas between the Arctic icepack and the Alaskan coastline. In mid-September freeze-up begins. During this period, new ice forms along the coastline and continues seaward until it contacts the Arctic ice pack in October.

This section presents a brief overview of weather conditions for the Beaufort Sea region and the impact that they could have on oil spill response operations. It is important for the OSC to recognize that adverse weather and other environmental conditions, such as moving broken ice, can significantly limit the extent to which cleanup activities can be implemented in the Beaufort Sea. A summary of environmental conditions for the broken ice season is provided in Figure 1.3.1 This figure highlights the impact that these conditions can have on oil spill response operations in the Beaufort Sea.

Figure 1.3.1	ENVIRONMENTAL CONSIDERATIONS FOR OIL SPILL RESPONSE IN BROKEN ICE		

Ref: Oil Spill Response In The Arctic - Part 1

Environmental Factor	Months J F M A M J J A S O N D → Typical Periods of Broken Ice	CONDITIONS	Influence on Response Operations
TEMPERATURE		• Mean Monthly air temperatures during these periods are approximately 41° F (breakup) and 16° F (freezeup).	• Reductions in performance for personnel and cleanup equipment. • Lower temperatures during freeze-up may cause ice buildup on skimming equipment and in storage and transfer systems. • Ice may form on vessels and on critical working areas due to wind-spray or freezing. • Low air temperatures, together with year-round low water temperatures, will increase the viscosity of spilled oil thereby reducing its tendency to spread. • The combined effects of wind and air temperature will result in chill factors that could damage exposed flesh.
VISIBILITY		•Visability is obstructed due to blowing snow, fog, smoke and/or haze (≤ 6 miles, 26% of the time & ≤ 2 miles 16% of the time). •Visibility is enhanced during breakup due to 24 hours of daylight. •Freeze-up has 10 to 12 hours of daylight plus twilight.	• Poor visibility may stop cleanup operations. • Aerial support for tracking oil and directing surface vessels to heavy oil concentrations will be affected as visibility drops below 6 miles and as ceilings drop below 1,000 feet. • Aircraft flying under IFR conditions can maintain most logistics support functions during reduced visibility. • Cleanup efforts can be conducted during low visibility using onsite/nearsite support facilities, barges, vessels and amphibious/ACV vehicles. • 24 hours of daylight during breakup will facilitate viewing conditions for tracking oil and cleanup.
MOVING BROKEN ICE (25-75% Coverage)		•Broken ice may consist of small ice cakes and brash ice, small to medium floes (65 to 1600 feet) or big floes (≥ 1600 feet). •Typical drift rates for ice are 1 to 3% of the wind speed. Average drift rates (for an average wind speed of 10 knots) would be approximately 0.2 knot or 3 to 4 inches per second.	• Moving ice during breakup will generally flow slowly toward the west with a gradual drift seaward (except during strong, counter-acting winds). This trend along with persistent landfast ice accumulations along shorelines may tend to keep oil away from the mainland. • Natural ice containment of oil (melt pools) will give way to oil migration between ice floes allowing surface transport. • Heavy concentrations of moving broken ice will preclude most fixed-position containment and recovery operations. Tugs, barges and helicopters can be used to deploy free-drifting or ice anchored fire containment booms, to release igniters, to deploy over-the-side skimmers (e.g. rope mops), to support incineration/flaring operations, and to support the transfer and storage needs of skimming vessels and various manual removal activities. • Moving thin/slush ice during freeze-up will transport oil while limiting its spread.
WINDS		•Instantaneous winds ≥30 kts are highly unlikely during breakup. The avg. no. of days with such winds for July is .33 (10 days in 30 years). •Broken ice with strong wind & wave conditions are more likely during the fall. One to 2 storms/yr. might produce ice drift rates of approx. 2 ft./sec. for 24 to 36 hrs.	• Sustained strong winds can generate significant wave heights when ice concentrations are below 50 to 60%. Moving broken ice during these conditions would normally bring spill containment & recovery operations to a temporary halt. Sustained winds (≥ 12 hours) in excess of 23 knots occur an average of less than once per month throughout the year (AEIDC, 1983). • Storm conditions (with moving ice) would limit tug and barge activities to emergency support functions, while aircraft would be deployed only as necessary to monitor oil spill movement and transport personnel and equipment. Sling loading of equipment would be hampered as well. • Strong winds can generate dangerous chill factors particularly during the freeze-up period. • Storm conditions may drive low ice concentrations into tightly packed high concentrations where mechanical recovery becomes impossible. • Winds greather than 20 knots may significantly reduce the effectiveness of most skimming equipment and booms.

1.3.1 Temperature and Precipitation

As shown in Table 1.3.1.1, temperatures in the Beaufort Sea region can range from -50°F to 75°F. However, for many locations in this region, the monthly mean temperatures range from -20°F to 41°F. In Arctic conditions it is important to recognize the impact that the wind chill factor can have on personnel. The wind chill factor is defined as the equivalent still-air temperature that would have the same cooling effect on exposed human flesh as a given combination of temperature and wind speed. As shown in Table 1.3.1.2, an 8.7 knot (10 mile per hour) wind at 0°F will produce a resulting wind chill factor of -21°F. During the winter months, low wind chill factors can limit the extent to which personnel can participate in outdoor activities.

Along with low temperatures, the Beaufort Sea region receives about 2½ in. of rain per year and approximately 24 in. of snow. July and August generally receive the most rain, while October is generally the month for peak snowfall.

1.3.2 Wind

The average wind speed for the Beaufort Sea region is approximately 10 knots (12 miles per hour). However, winds may reach speeds up to 70 knots (80 miles per hour) during storms. A summary of wind speeds and directions for this region is provided in Table 1.3.2.

1.3.3 Visibility

May, June, and July are periods of 24-hour daylight throughout the Beaufort Sea region. December and January are periods of 24-hour darkness. Other months have varying degrees of light and darkness as shown in Figure 1.3.3.

Between May and September, fog can restrict visibility about 25% of the time. At some locations fog may exist for 100 or more days a year. Blowing snow can also restrict visibility. From November through March blowing snow exists approximately 15% of the time. Table 1.3.3 provides summarized visibility reductions resulting from fog and blowing snow.

Visibility can also be severely restricted by whiteouts. A whiteout is defined as those conditions where it is impossible to visually distinguish between the ground and horizon in a snow covered area. In the interest of safety, oil spill cleanup activities, ground transportation, and air traffic (without appropriate instrumentation) should be suspended during whiteouts.

Table 1.3.1.1

TEMPERATURE AND PRECIPITATION IN THE BEAUFORT SEA AREA

(CLIMATIC ATLAS - 1977)

MEAN AIR TEMPERATURE °F

MONTH	BARROW	LONELY	OLIKTOK	BARTER ISLAND
JANUARY	-15	-17	-17	-15
FEBRUARY	-20	-20	-20	-20
MARCH	-17	-18	-18	-18
APRIL	-2	-2	-2	0
MAY	19	21	21	21
JUNE	32	34	34	34
JULY	39	41	41	39
AUGUST	37	39	39	39
SEPTEMBER	30	30	32	32
OCTOBER	14	14	14	16
NOVEMBER	-15	-15	-15	-15
DECEMBER	-15	-2	-4	0

Table 1.3.1.2

WIND CHILL FACTOR CHART

Temperature (Fahrenheit)	Wind Chill Temperature 8.7 Knots (10 mph)	17.4 Knots (20 mph)	26 Knots (30 mph)	39.1 Knots (45 mph)
40	28	18	13	10
30	16	4	- 2	- 6
20	4	-10	- 18	- 22
10	- 9	-25	- 33	- 38
0	-21	-39	- 48	- 54
-10	-33	-53	- 63	- 70
-20	-46	-67	- 79	- 85
-30	-58	-82	- 94	-102
-40	-70	-96	-109	-117

Ref: The Alaska Almanac

TABLE 1.3.2

WIND SPEED (KNOTS) AND DIRECTION [1][2]

(CLIMATIC ATLAS, 1977)

MONTH	BARROW	LONELY	OLIKTOK	BARTER ISLAND
JANUARY	10.3 E, NE	9.1 E, NE	11.4 SW, NE	13.0 W, E
FEBRUARY	9.2 E, NE	7-8 NE, E	9.9 NE, SW	12.1 W, E
MARCH	9.9 E, NE	8.1 NE, E	10.2 NE, SW	11.8 W, E
APRIL	10.0 E, NE	7.9 NE, E	9.4 NE, E	10.3 E, W
MAY	10.1 E, NE	8.0 E, NE	9.2 E, NE	10.6 E, W
JUNE	10.1 E, NE	8.2 E, NE	9.3 E, NE	9.8 E, NE
JULY	10.0 E, NE	7.8 E, NE	9.0 NE, E	9.2 E, NE
AUGUST	10.6 E, NE	8.4 E, NE	9.5 E, NE	10.0 E, W
SEPTEMBER	11.1 E, NE	9.5 E, NE	10.9 E, NE	11.4 E, W
OCTOBER	11.2 E, NE	9.6 NE, E	10.5 NE, E	12.4 E, W
NOVEMBER	11.8 E, NE	10.7 NE, E	11.7 NE, E	13.2 E, W
DECEMBER	9.5 E, NE	8.3 NE, E	10.4 SW, NE	12.3 W, E

Note: 1. Wind speeds are mean scalar wind speed.
2. Directions are listed in their order of frequency.

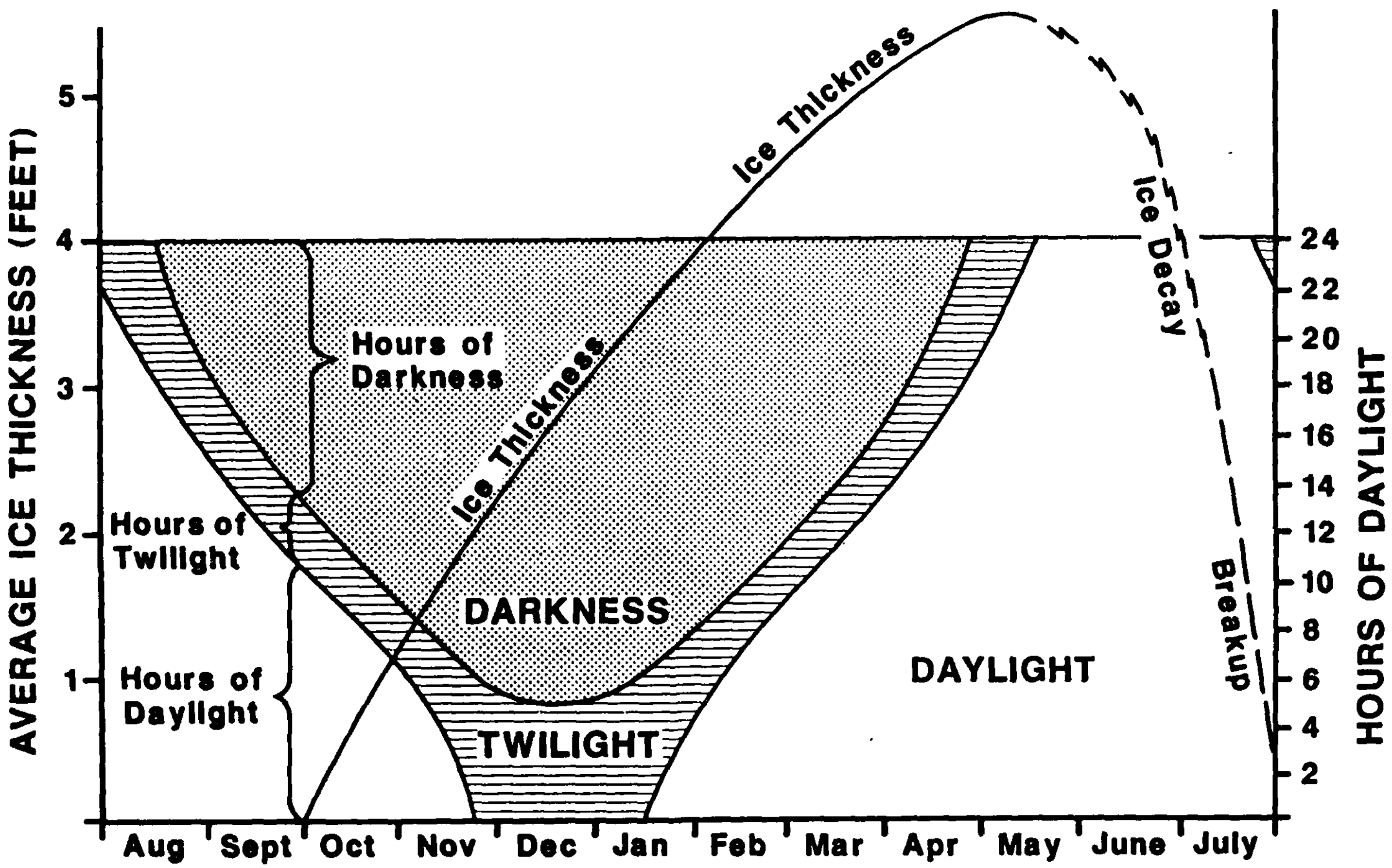


Figure 1.3.3

DAYLIGHT AND SEA ICE CONDITIONS - BEAUFORT SEA

Table 1.3.3

PERCENT FREQUENCY OF OCCURRENCE OF
OBSTRUCTIONS TO VISION

MONTH	% TIME VISIBILITY 6 MILES OR LESS (1) Fog	Blowing Snow	% TIME VISIBILITY 1/2 MILE OR LESS (2)
January	12.5	13.7	5
February	13.1	12.6	5
March	7.9	10.0	4
April	9.3	7.8	4
May	17.4	4.0	7
June	26.4	0.5	9
July	25.9	---	9
August	25.5	0.0	9
September	17.7	0.7	5
October	13.0	7.7	4
November	10.5	16.3	8
December	10.4	13.5	5
ANNUAL MEAN	15.8	7.2	6.2

Sources: 1. Alaska Regional Profile, Arctic Region.
2. Climatic Atlas, 1977

1.3.4 Effects of Climate on Cleanup Operations

Poor weather can hinder oil spill cleanup operations. However, adequate planning and advance preparation can facilitate an effective response. For example, personnel participating in winter cleanup operations should be provided arctic clothing. Also, heated shelters containing food and hot beverages should be setup near the cleanup site. To decrease the time that personnel will have to work outside, equipment selected for the cleanup operation should be easy to operate and capable of cleaning up large quantities of oil and oil contaminated snow.

1.3.5 On-Shore Environment

Seasonal changes in both weather and terrain present unique challenges for industrial operations on Alaska's North Slope. In most locations, the ground is permanently frozen and covered with a layer of tundra that freezes during the winter months and thaws during the spring. The tundra is extremely sensitive and subject to damage by conventional vehicles. Federal and state permits are required for surface transportation across the tundra. In order to place permanent facilities on the tundra, it is necessary to construct an insulating pad of sand and gravel to protect the tundra and underlying permafrost from heat emitted by the facility. Usually these insulated pads must be at least five feet thick. Gravel and sand pads are also needed for roads and airstrips on tundra.

1.3.6 Off-Shore Environment

1.3.6.1 Oceanography

Oceanographic information is needed to determine the behavior of spilled oil that spills offshore and the actions required to contain and recover it. As shown in Figure 1.3.6.1, circulation in the Beaufort Sea is generally from east to west.

Coastal waters in the Beaufort Sea are very shallow. In some locations, Harrison Bay for example, water depths may be 7 ft. or less as far as 1 mile from shore. Also, 3 to 6 ft. water depths frequently exist up to 1,000 ft. from shore and inside of the barrier islands. In view of this, oil spill cleanup in these shallow waters may prove to be somewhat difficult, because many of the vessels which would be used (Arcat Skimmer and barges) have drafts that exceed 6 ft.

Near-shore currents are strongly influenced by local winds. Southwesterly winds, produced by low pressure systems over Alaska, and infrequent westerly storms encountered mainly in late summer and fall may cause easterly flow and higher sea levels. Current reversals have been observed a few hours after a change in wind direction from east to west or vice versa. However, about 70 percent of the time winds are from the east causing surface currents to move towards the west.

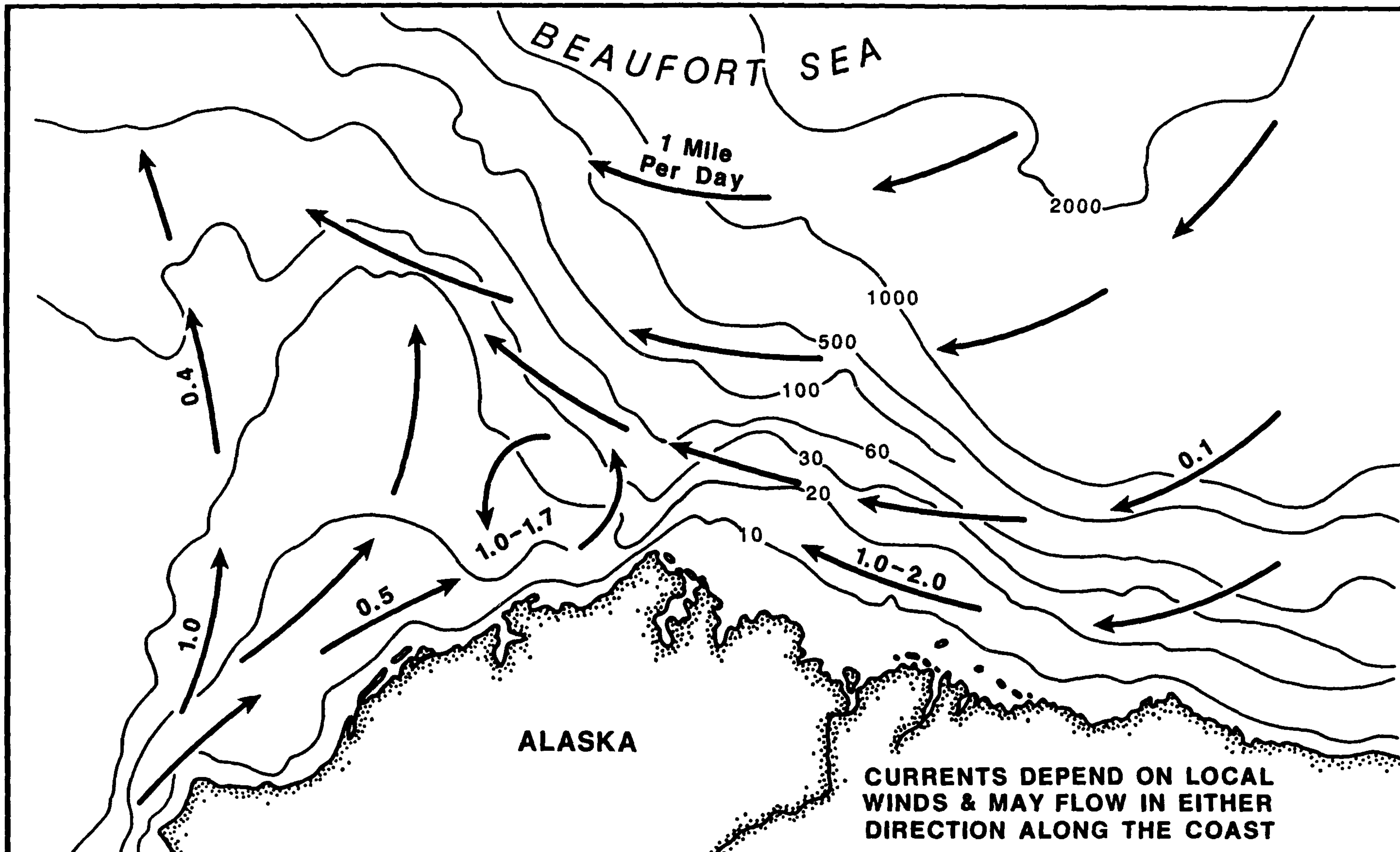


Figure 1.3.6.1

GENERAL SURFACE CIRCULATION
OF THE BEAUFORT SEA

Ref. ALASKA REGIONAL PROFILE, ARCTIC REGION

1.3.6.2 Sea Ice

1.3.6.2.1 Landfast and Pack Ice

Ice is present in the Beaufort Sea throughout the year. New ice begins to form along the Beaufort Sea shoreline between late September and early October. By late October, the new pack ice is also forming offshore. As the two ice zones grow, they contact each other and form a grounded ice region at their interface (Figure 1.3.6.2.1). Ice continues to grow through February and achieves a maximum thickness varying from 5 to 6 ft. Melting usually begins by late May. Breakup occurs during late June. Open water typically occurs during mid-August and exists through mid-September.

The Arctic ice pack normally lies 20 to 50 miles offshore during the open water season. The position of the ice pack boundary will vary depending on wind speed and direction.

1.3.6.2.2 Ice Formation Characteristics

The changing characteristics of first-year ice throughout its annual cycle are important to oil spill response operations. Early in the ice cycle, ice forms as a thin sheet in calm water or as a thick layer of slush in agitated water. The latter freezes solid after enough slush accumulates to dampen wave action. In either case, first-year ice grows downward by crystal formation in a weak, porous skeleton. Oil spilled beneath the ice would tend to penetrate the skeleton and enter brine channels above it. Trapped oil will penetrate the upper ice surface through these channels and form pools on the ice surface by May.

1.3.7 Arctic Wildlife

With respect to the offshore environment, marine mammals are of particular importance. For example, the bowhead whale migrates through the Beaufort Sea during the fall and spring of each year. Along with being an endangered species, this whale is a valuable subsistence and cultural resource for Alaskan Eskimos who live on the North Slope.

Polar bears, walruses, and seals are other important marine mammals that inhabit the Beaufort Sea environment. Also, lagoons and barrier islands in this region provide valuable nesting and feeding areas for migratory birds. Therefore, it is important that these regions be protected if an oil spill were to occur.

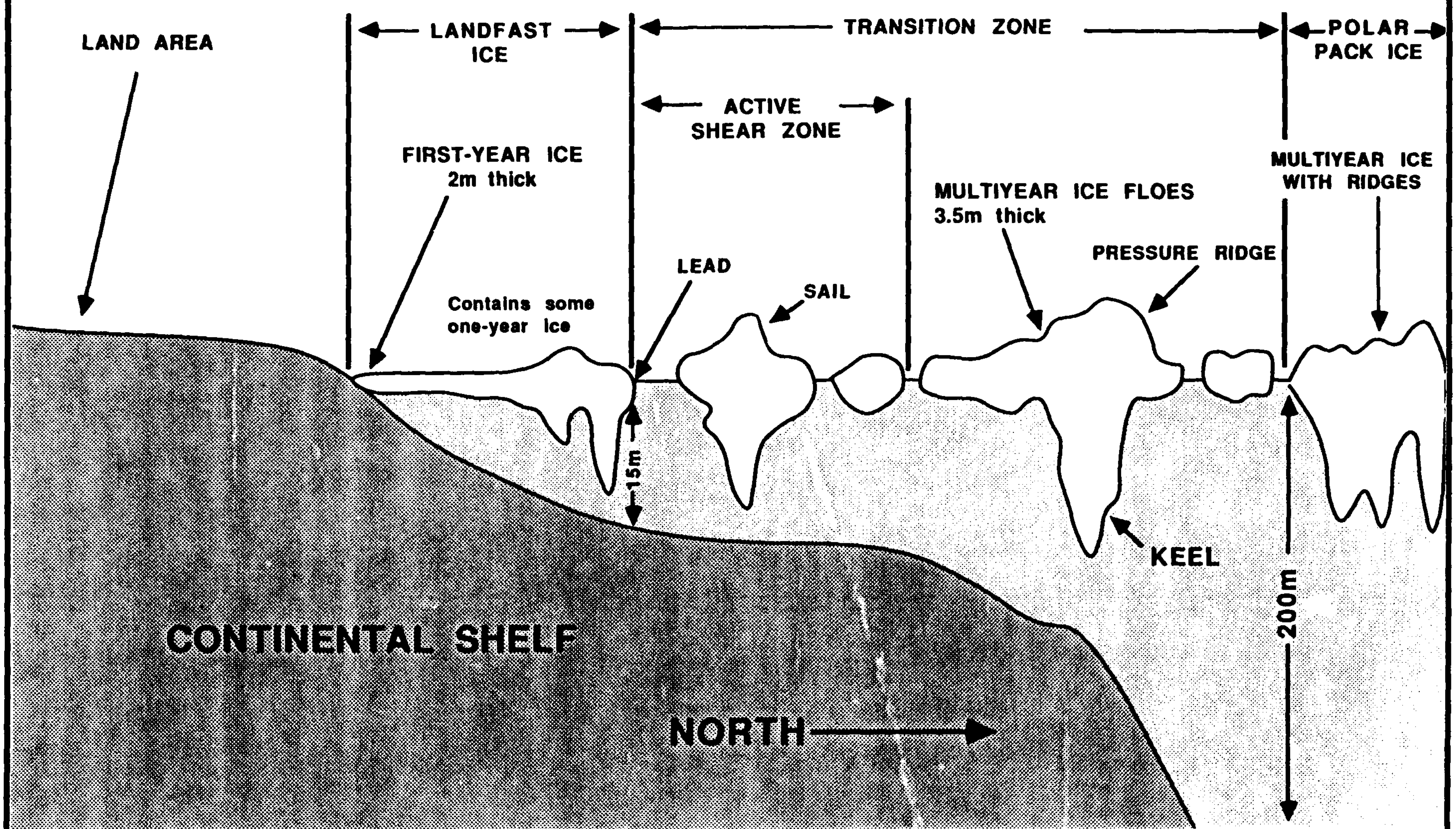


Figure 1.3.6.2.1

WINTER ICE TERMINOLOGY

for the Alaskan Beaufort Sea

1.4 Beaufort Sea Drilling Activity

1.4.1 Ice Islands

As shown in Figure 1.4.1, a number of unique structures are used for drilling operations in the Beaufort Sea. During November of 1976, a 220 foot by 375 foot ice island was constructed by spraying sea water in thin layers over the existing ice surface. This process was continued until the ice island was 12 feet thick and firmly grounded on the sea floor (normally the maximum ice thickness in the near-shore Beaufort Sea region is 6 feet or less). After the island was completed, drilling equipment and living quarters were installed and an exploration well was completed. Ice islands are still used for Beaufort Sea exploration. For example, Amoco Production Company used an ice island to drill an exploration well in the Beaufort Sea during 1986.

Ice islands have one principal limitation, i.e., they can only be used during the winter months. As the temperature increases with the onset of spring, these islands gradually melt. However, these islands are used because they are relatively inexpensive to construct.

1.4.2 Gravel Island

Man-made gravel islands are by far the most common drilling structure to date. A typical gravel island in 20 feet of water will require approximately 250,000 cubic yards of gravel and will be approximately 300 feet in diameter and about 10 feet above the surface. Since gravel is in very short supply in the Beaufort Sea region, economic considerations limit gravel islands to water depths of 40 feet or less. For example, a gravel island in 60 feet of water would require approximately 2,500,000 cubic yards of gravel. In other words, ten times as much gravel would be required to construct a gravel island in 60 feet of water than in 20 feet of water.

Along with cost, another disadvantage inherent in gravel islands is that they are fixed structures. Consequently, if the well is a dry hole, all costs associated with constructing the island are lost. To resolve this problem, industry is beginning to replace gravel islands with mobile platforms.

1.4.3 Concrete Islands

During the 1984 drilling season, Exxon Company USA used Global Marine's Concrete Island Drilling System (CIDS) to drill wells on a federal tract in the Beaufort Sea. As shown in Figure 1.4.3, the CIDS contains three sections. The bottom section is a 25 foot high steel "mud base" which is flooded with sea water to ballast the structure. The middle section is 44 feet high and constructed from steel reinforced, pre-stressed concrete. The top section consists of two connected steel storage barges. The deck is approximately 290 feet by 270 feet.

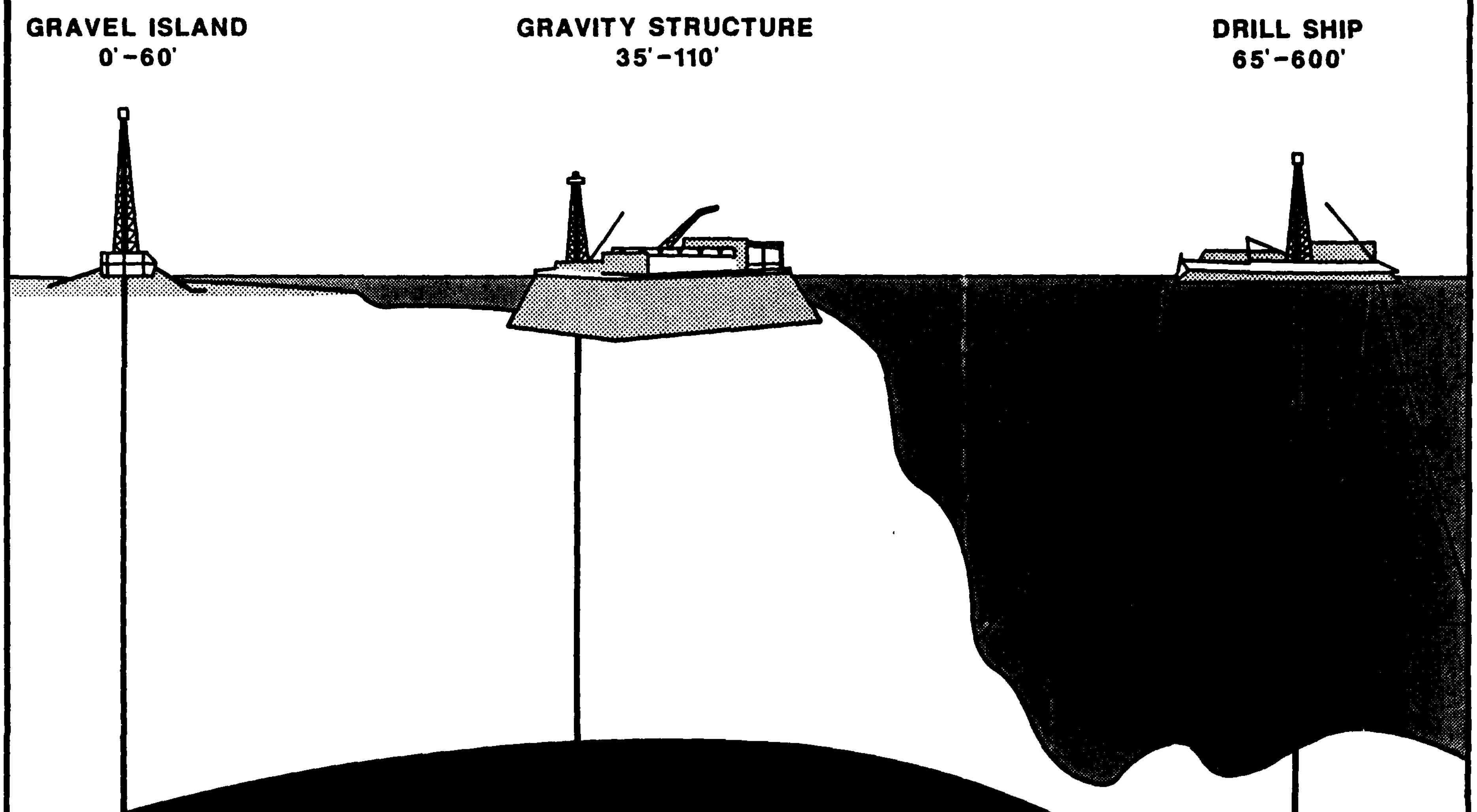


Figure 1.4.1 BEAUFORT SEA DRILLING STRUCTURES

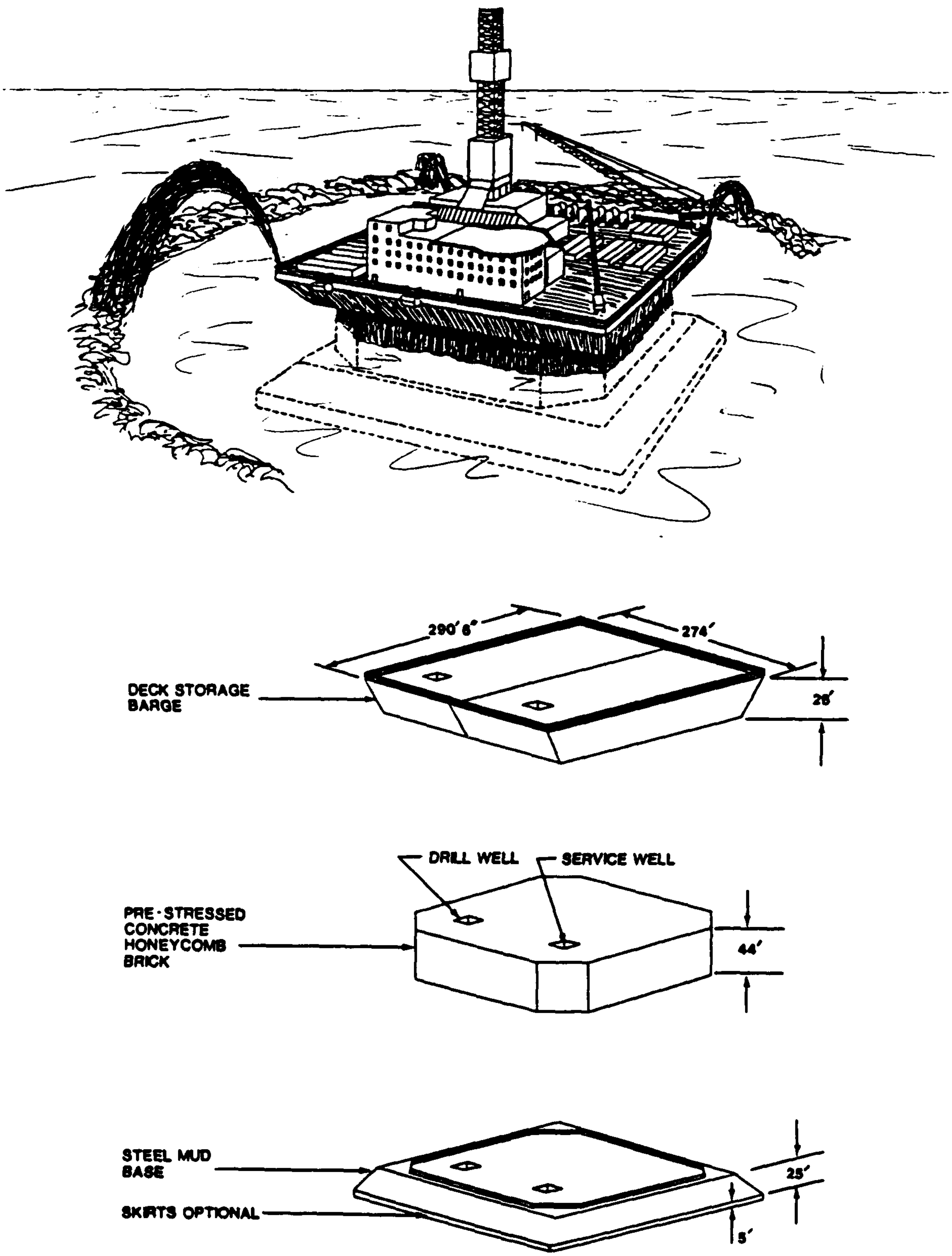


Figure 1.4.3	GLOBAL MARINE'S CONCRETE ISLAND DRILLING SYSTEM

The CIDS includes three water cannons that are used to build an ice barrier. This barrier serves to protect the CIDS from ice forces created by shifting winds. Once drilling operations are completed and breakup begins, the CIDS is floated and moved to a different drilling location. Similar to man-made gravel islands, the CIDS can be used on a year-round basis in the Beaufort Sea.

1.4.4 Drillships

Drillships provide a cost effective alternative for exploratory drilling in the Beaufort Sea. Although drillships have been used in the Canadian Beaufort Sea since the late 1970's, the first drillship operation in the Alaskan Beaufort Sea was conducted during the summer of 1985.

Drillships differ from drilling structures which rest on the sea floor (bottom-founded structures) in several respects. Perhaps the most important difference is that the blowout preventer is located on the sea floor as opposed to the drilling structure, (Figure 1.4.4). Therefore, if a blowout results from drillship operation, the oil will be released below the water surface. Consequently, oil spill countermeasures may not be effective and considerable time may be required for well control.

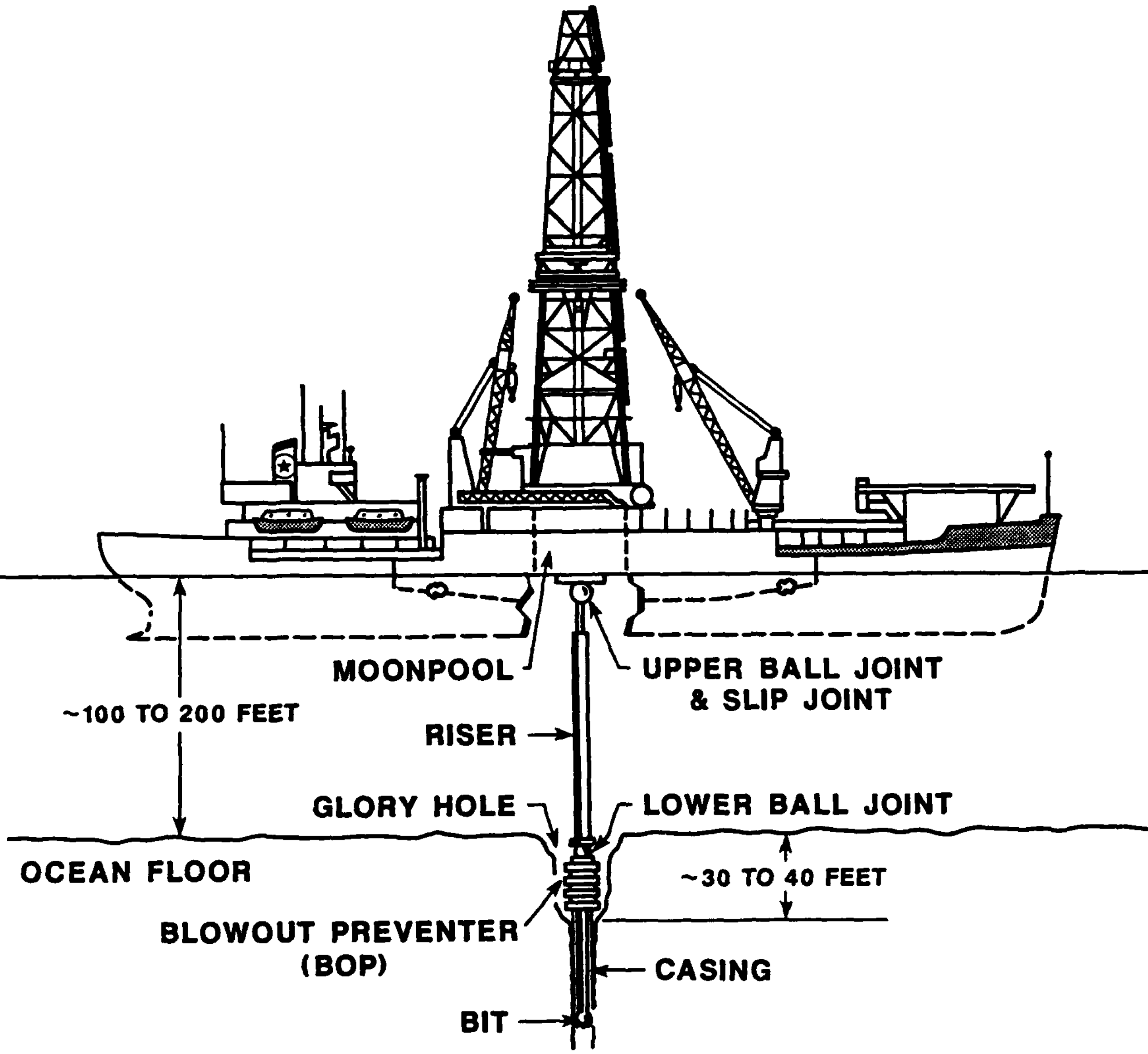
Unlike bottom-founded drilling structures which have a 12-month drilling season, ice conditions limit drillships to a 90-day season beginning about mid-July and ending during mid-October. Furthermore, ice encroachment can significantly reduce the number of days available for drillship operation. For example, if heavy ice conditions develop, it may become necessary for the drillship to abandon operation and seek shelter. This could occur several times during the course of completing a single well. If an oil well blowout occurs, ice conditions could also prevent relief well activity.

Another problem inherent to drillship operation, is that the operating season overlaps the fall migration of bowhead whales. To protect these endangered species from an oil spill, both state and federal stipulations may require that the drilling operation stop until the migration is completed.

A drillship is generally supported by two or more supply vessels and an ice breaker. As the name implies, the supply vessels transport drilling materials from the base on shore to the drillship. The ice breaker protects the drillship by moving or breaking ice that could force it off location.

1.5 Description of Planning Guide

As discussed in Section 1.1, this Planning Guide has been prepared to familiarize the U.S. Coast Guard On-Scene Coordinator (OSC) with the equipment, techniques and logistics necessary for responding to oil spills in the Alaskan Beaufort Sea. The



Canmar Explorer II is one of the four drillships developed for offshore oil and gas exploration in the Arctic. The hull has been built to ABS Ice Reinforced Type 1A Super Class 1AA specifications, is fully equipped for open water Arctic environmental conditions, and is classified by both ABS and Lloyd's registry. The vessel is held on location with eight mooring lines equipped with remote ancyor release units and collapsible pawls installed on the drums. The ship can therefore disconnect quickly from its anchors and withdraw from the drillsite in the event of heavy ice encroachment.

Figure 1.4.4	**DRILLSHIP - CANMAR EXPLORER II**

following information is provided to give the OSC a brief overview of the contents of this Planning Guide. The objective is to provide insight which will help the OSC discern where to look for specific information.

1.5.1 Section 2.0 - Federal Response Organization

This section describes the OSC's responsibilities as set forth by the National Oil and Hazardous Substance Pollution Contingency Plan (NCP). It also discusses the role of the National Response Team and the Alaska Regional Response Team.

The information presented in this section was taken from the November 20, 1985 revision of the NCP.

1.5.2 Section 3.0 - Initial Response

The initial response to an oil spill in the Beaufort Sea will play a key role in determining the magnitude of the cleanup operation and the spill's impact on the environment. This section examines the factors which govern the success or failure of the initial response operation. Its objective is to provide an understanding of when and where various response options are likely to be effective.

The section is also designed to serve as a primer for acquainting the OSC with the basic steps for containment and recovery for oil spills which could occur from drilling activity and fuel transportation in the Beaufort Sea. It considers specific drilling structures and provides a concise overview of the steps for the initial response during the solid ice, broken ice, and open water seasons. It also provides critical insight on the considerations that the OSC should entertain for blowouts, well control, well ignition, and dispersant deployment. Each of these topics are discussed in greater detail in Section 4.0 - Elements of Response.

1.5.3 Section 4.0 - Elements of Response

Elements of response include the equipment, personnel and logistics necessary for minimizing the environmental impact of an oil spill. This section provides a detailed discussion of these elements and helps the OSC fully understand the state-of-the-art for responding to oil spills in the Beaufort Sea.

The information provided in this section is based on: 1) input obtained from Oil Spill Consultants and Cleanup Contractors in Alaska, 2) a detailed review of oil spill research and development performed by organizations in Alaska and Canada, 3) data provided by equipment manufacturers, and 4) a review of oil spill response operations in U.S. and Canada waters. As a result, this section represents the best available information on response elements for the Alaskan Beaufort Sea.

Along with identifying the advantages and limitations inherent to existing oil spill containment, cleanup, and disposal techniques, this section provides a comprehensive listing of the cleanup equipment currently stockpiled in Alaska. Additionally, it identifies cleanup equipment owned by spill response co-ops, in California and Canada, and the **Pacific Area Strike Team (PAST)**.

This section has a Table of Contents which will help the OSC to quickly locate information on specific elements of response.

1.5.4 Section 5.0 - Mechanics of Response

This section is the heart of the Planning Guide. It provides a number of checklists and decision trees which are designed to help plan the proper response for spills that occur during any season in the Beaufort Sea. The checklists and decision trees will direct the user to other sections of the Planning Guide which provide pertinent information for specific response considerations.

1.5.5 Section 6.0 - Scenarios

By definition a scenario is a script, real or imagined, that outlines a specific event from beginning to end. It identifies the characters who participate in this event and reveals how their roles contribute to the outcome.

This section of the Planning Guide contains seven oil spill scenarios. Their objective is to familiarize the OSC with the considerations and decision processes for responding to oil spills in the Beaufort Sea. They also identify problems which could occur during a response operation and suggest solutions for resolving them.

Although each scenario is hypothetical, they are based on events which have occurred in either the Alaskan or Canadian Beaufort Sea or the Gulf of Mexico. Although the scenarios are hypothetical, the necessary personnel and equipment actually exist. Additionally, the environmental conditions and spill behavior are representative of the conditions which could exist in the Beaufort Sea.

To ensure that these scenarios reflect the state-of-the-art for arctic oil spill response, input was obtained from Oil Spill Consultants in Alaska. Along with this, numerous scenarios prepared by the Oil Industry for the Beaufort Sea were reviewed for this section.

1.5.6 Section 7.0 - Appendices

This section supplements the information provided in Section 4.0 - Elements of Response. It provides additional information on

cleanup equipment. It also includes Alaska state policy on open burning and state/federal oil spill contingency planning criteria.

1.5.7 Section 8.0 Bibliography

1.5.8 Section 9.0 Definitions

Terms commonly used to discuss oil spill response activities in Alaska are defined in this section.

2.0 FEDERAL RESPONSE ORGANIZATION

2.1 National Contingency Plan

In 1968, the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) was established to coordinate federal activities for preventing oil spills and mitigating environmental damages when spills occur. During June 1970, this plan was incorporated as part of the Code of Federal Regulations and applied to all navigable waters and adjoining shorelines of the United States.

To ensure that adequate preplanning and provisions are available for responding to oil spills, the National Contingency Plan established the National Response Center, the National Response Team, the Regional Response Center, Regional Response Teams and the On-Scene Coordinator (Figure 2.1). Each of these organizations and positions will be discussed in the following sections.

2.2 National Response Team (NRT)

National planning and coordination for oil spill response is performed by the National Response Team (NRT). The NRT is primarily responsible for maintaining the National Contingency Plan, evaluating methods for responding to oil spills and hazardous substances spills, and recommending changes to the National Contingency Plan to ensure that adequate response capability is available. The NRT is also responsible for developing procedures to ensure that oil spill response activities by federal, state and local governments, and private response organizations are properly coordinated.

The NRT consists of representatives from each of the agencies shown in Figure 2.2. Normally, the NRT is chaired by the EPA representative while the USCG representative serves as the vice-chairman. When the NRT is activated for inland spills, the EPA representative will be the chairman. If it is activated for spills within the coastal zone of the United States, the USCG representative will hold the chair.

The NRT can be activated as an emergency response team:

- o when an oil spill or hazardous substance spill exceeds the capability of the Regional Response Team in which it occurs, transects national boundaries, or presents a significant threat to a population, national policy, property, or natural resources.
- o if requested by any NRT member.

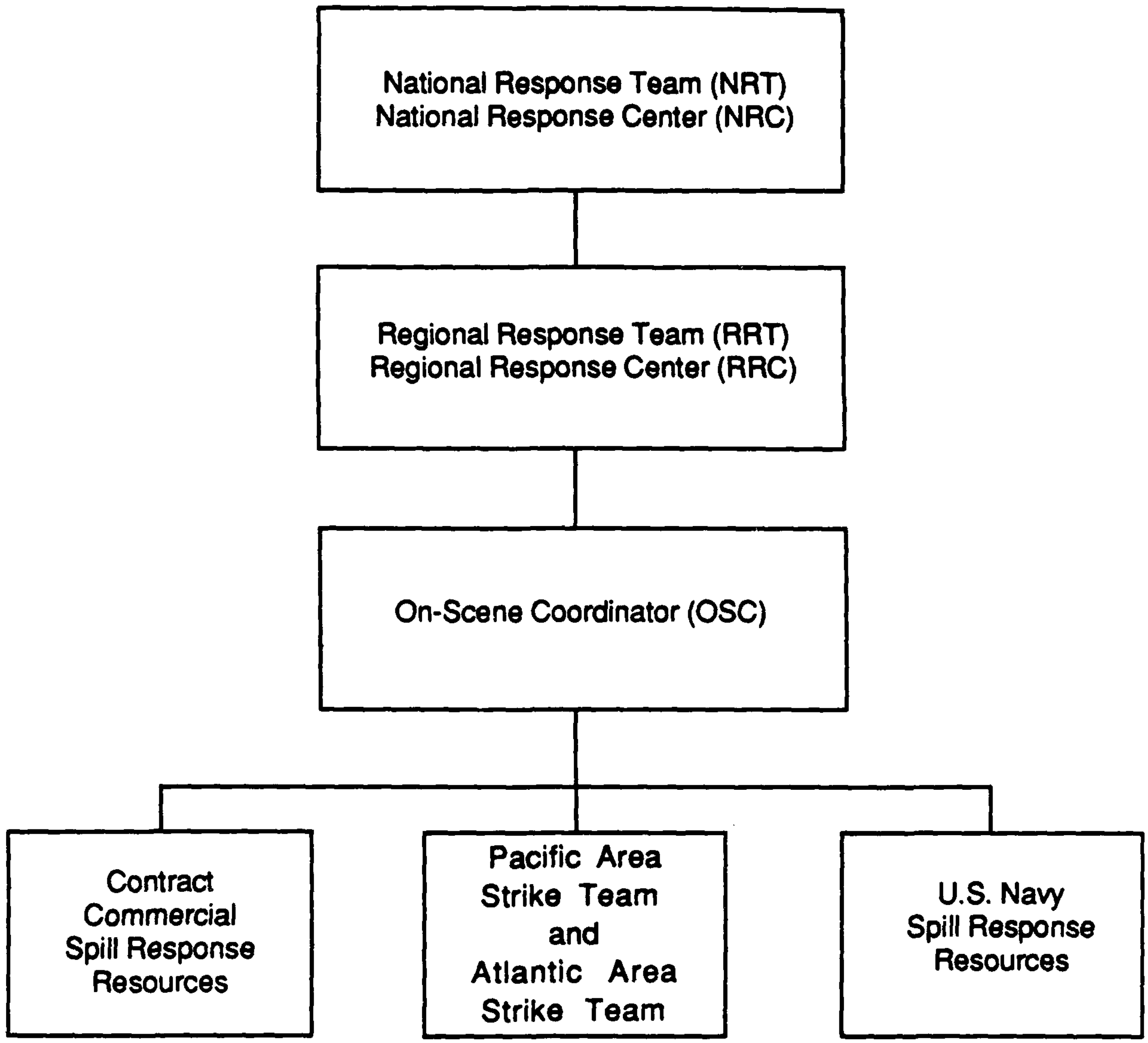


Figure 2.1 **FEDERAL RESPONSE ORGANIZATION**

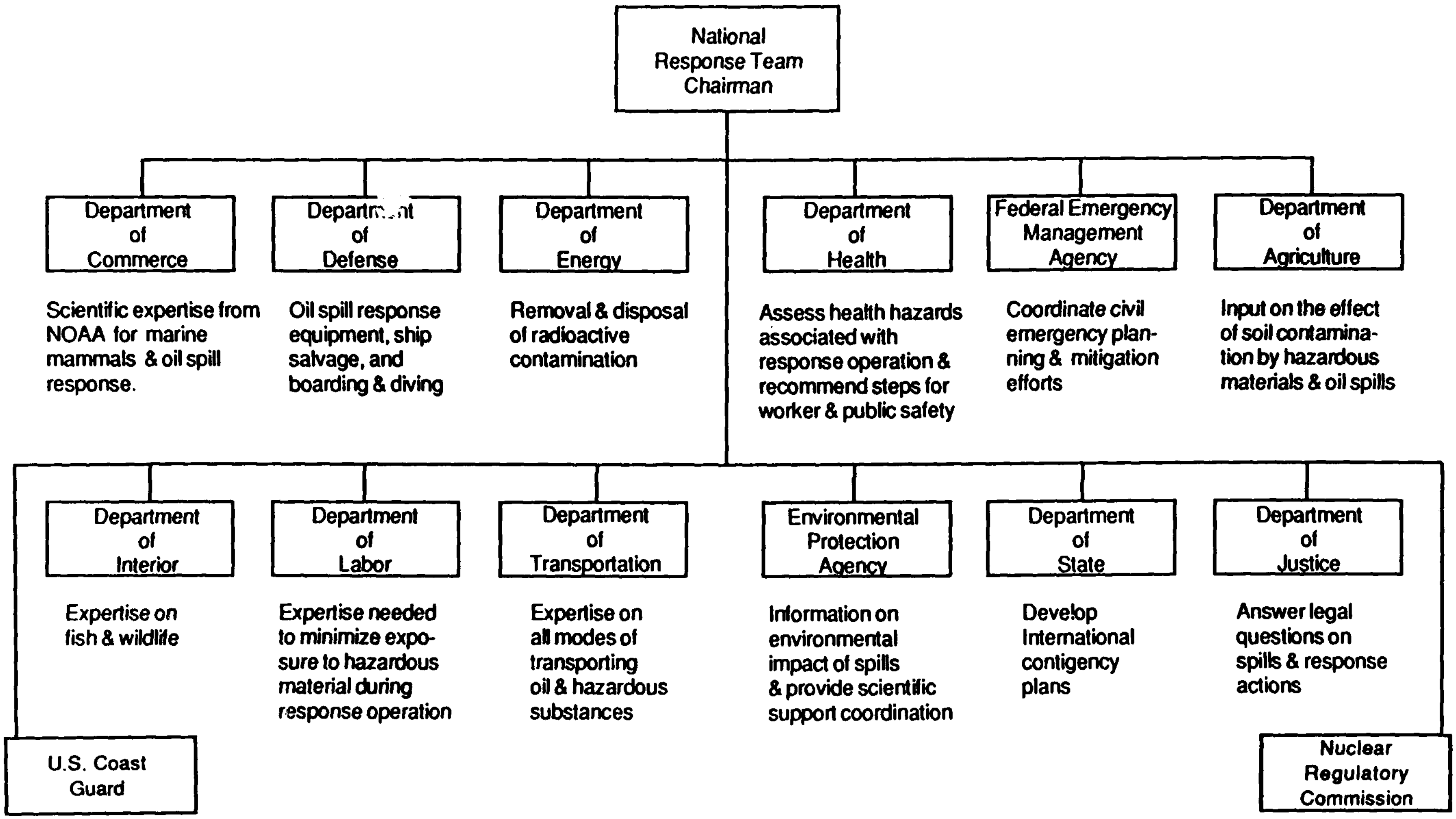


Figure 2.2 FEDERAL REPRESENTATION ON NATIONAL RESPONSE TEAM

Once the NRT is activated it may:

- o monitor the spill, evaluate reports from the On-Scene Coordinator, and recommend appropriate actions for abating the spill.
- o request oil spill response resources from federal, state, local, or private organizations.
- o coordinate other activities as may be required to ensure that an effective oil spill response plan is in operation.

2.3 National Response Center (NRC)

The National Response Center (NRC) is a national communication center for receiving and distributing reports regarding oil and hazardous substances spills. The NRC is located at the USCG Headquarters in Washington, D.C. and can be contacted by dialing 1-800-424-8802 or 1-202-267-2675. All spill reports received by the NRC are immediately telephoned to the On-Scene Coordinator which has jurisdiction over the region where the spill occurred.

Oil spills may be discovered through any of the following processes:

- o a report may be submitted by the person in charge of the vessel or facility in accordance with regulatory requirements.
- o deliberate search patrols.
- o random or incidental observation by government agencies or the public.

All oil spills must be reported to the National Response Center. If a direct report to the National Response Center is not practical, reports may be made to the USCG or EPA predesignated OSC for the geographic area where the spill occurs. If it is not possible to immediately notify the National Response Center or the predesignated OSC, reports may be made immediately to the nearest USCG unit provided that the spiller notifies the NRC as soon as possible. Once the NRC receives notification of a spill, it will promptly notify the appropriate OSC and authorize him to proceed with the appropriate response actions as outlined in the National Contingency Plan.

2.4 Regional Response Team (RRT)

The Regional Response Team (RRT) is responsible for developing oil spill response contingency plans for specific regions of the United States. This team is staffed by representatives from the

agencies shown in Figure 2.2 and may include representatives of local governments as agreed upon by the specific state in which the RRT is operative.

The RRT is jointly chaired by the EPA and USCG representative. When the RRT is activated for inland spills, the EPA representative will be the chairperson. If it is activated for spills in the coastal zone of the United States, the USCG representative shall be the chairperson unless otherwise specified or agreed upon.

The RRT includes two components; a standing team and an incident-specific team. The standing team is responsible for:

- o reviewing regional and local responses to various spills, recommending revisions to the National Contingency Plan, encouraging state and local communities to improve their preparedness for oil spill response activities, and reviewing actions performed by the On-Scene Coordinator.

- o advanced planning for dispersants, surface collection agents, burning agents, biological additives, or other chemical agents that are authorized by the National Contingency Plan.

The incident-specific response team can be activated if an oil spill exceeds the response capability available to the On-Scene Coordinator, if the spill transects regional boundaries, or if a spill presents a substantial threat to human health and welfare, the environment, or significant amounts of property. This team may also be activated during any pollution emergency by request of the On-Scene Coordinator or a request by any RRT representative.

When the incident-specific response team is activated, it may:

- o monitor and evaluate reports from the On-Scene Coordinator and recommend specific actions for improving the response operation.

- o request federal, state or local governments, or private organizations to provide resources for responding to the spill.

- o help the On-Scene Coordinator prepare information releases for the public.

- o recommend that a different OSC be designated for the response operation.

- o provide information that will assist the OSC to make timely and appropriate decisions for the response operations.

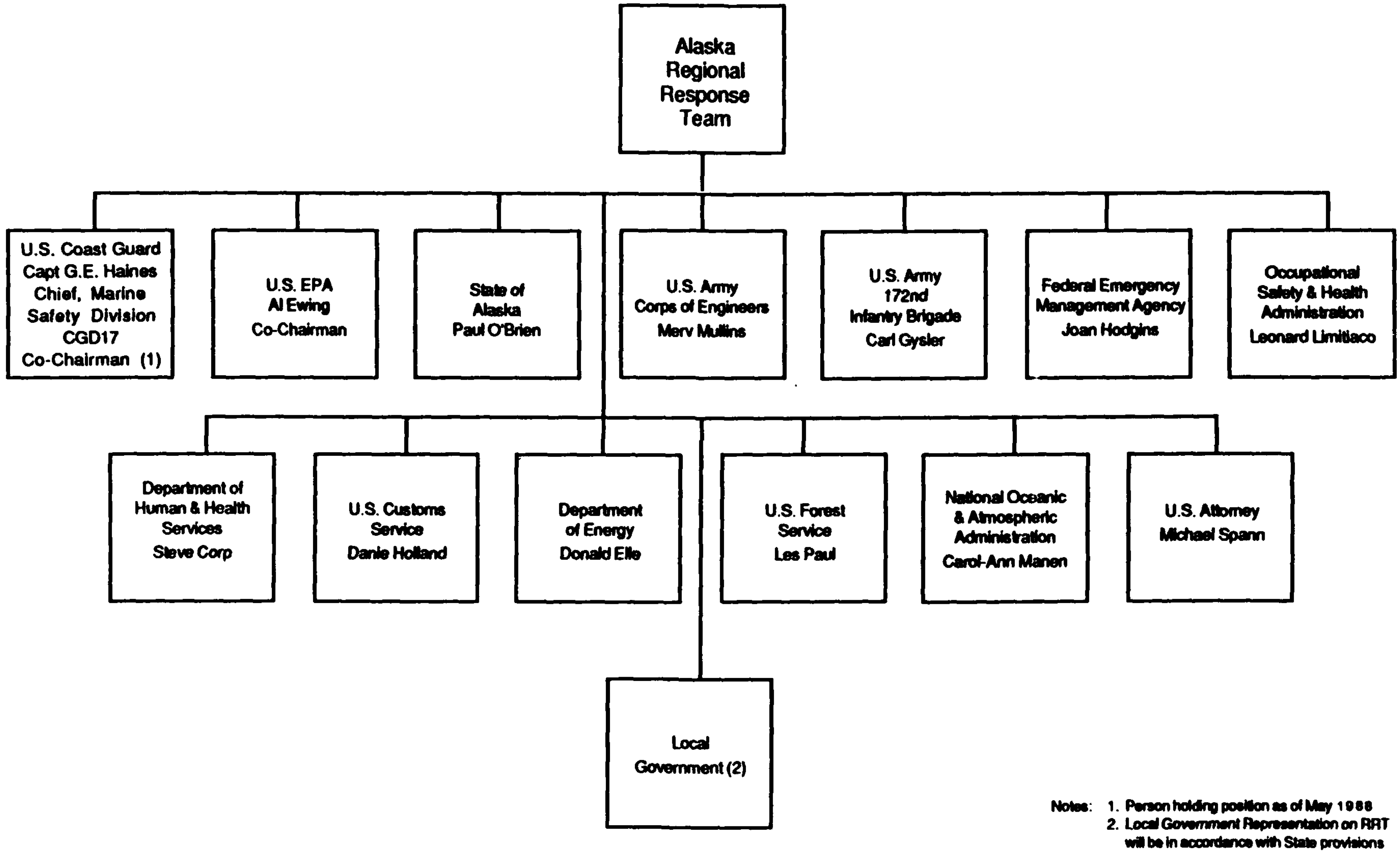


Figure 2.4

ALASKA REGIONAL RESPONSE TEAM

An incident-specific response team can be deactivated when the incident-specific RRT chairperson determines that the On-Scene Coordinator no longer requires its assistance.

2.5 Regional Response Center (RRC)

The primary Regional Response Center for the Alaskan Coastal Region is located at the 17th Coast Guard District Office in the Federal Building in Juneau, Alaska. The Regional Response Center is comprised of several rooms including the Operations Center, the Communications Center, the Main 7th Floor Conference Room, and the Marine Safety Division Offices.

An alternate RRC is located in the Federal Building in Anchorage. This location serves as the RRC for Alaskan inland regions. Because the main offices of some RRT members are located in Juneau and others in Anchorage, regular semi-annual meetings of the Alaskan Coastal RRT as well as the joint inland/coastal RRT meetings are normally alternated between Juneau and Anchorage. As a rule, during actual spill situations, those agencies with offices in Anchorage will meet at the alternate RRC in Anchorage and those located in Juneau will meet at the primary RRC. Speaker phones are located in both places to facilitate communications between them.

2.6 On-Scene Coordinators

On-Scene Coordinators (OSC) are predesignated federal officials from the U.S. Coast Guard or Environmental Protection Agency. As required by the National Contingency Plan, the OSC collects pertinent facts about the spill, its source and cause, and the parties responsible for the spill. The OSC also determines the potential impact that the spill could have on human health and welfare, and whether it presents a significant threat to the environment. Additionally, the OSC must establish priorities for minimizing the impact of oil spills. Finally, the person holding this position must document the cost for responding to and cleaning up the oil spill.

If the spiller assumes responsibility for the spill, the OSC will monitor the cleanup activity and ensure that it is done right. If the spiller does not assume responsibility, the OSC will initiate the response operation and hire commercial contractors as required to ensure that cleanup is accomplished as quickly as possible (Figure 2.6). If commercial resources are not available, the OSC will deploy federal resources. Federal personnel and equipment can be obtained from the National Strike Force and the U.S. Navy.

When a spill report is received, the OSC shall implement the following actions:

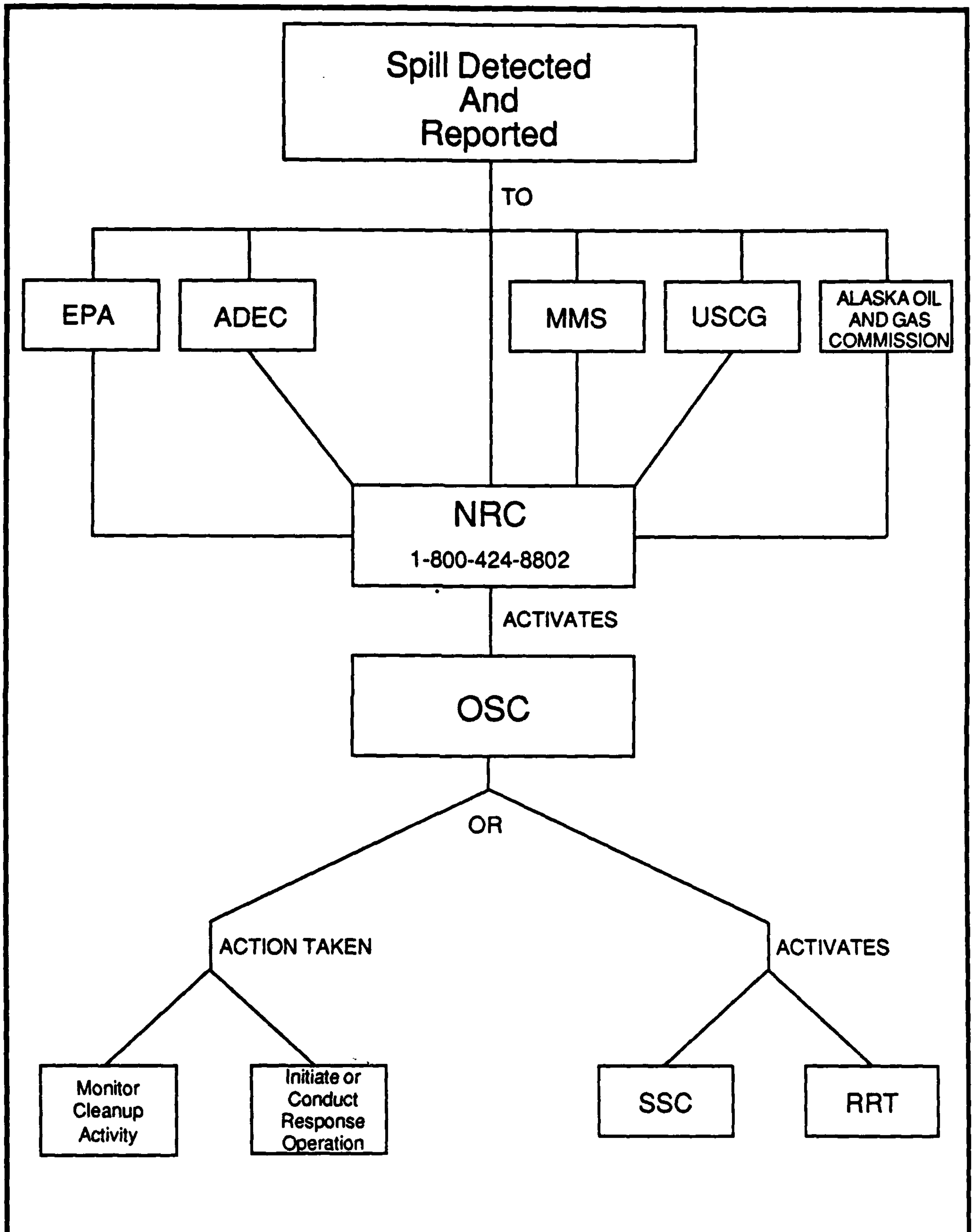


Figure 2.6	**OSC/RRT ACTIVATION**

- immediately notify the Regional Response Team and National Response Center.

- investigate the report to determine pertinent information such as the threat posed to public health and welfare, or the environment.

- officially classify the size of the discharge and determine the course of action to be followed.

- determine whether the spiller is properly carrying out the cleanup operation.

- determine whether the state or local government has the capability to carry out response actions and if a contract or cooperative agreement has been established with the appropriate Fund Administrator for this purpose.

- notify the Regional Response Team and the trustees of the affected natural resources in accordance with the applicable regional plan.

Within 60 days after a major oil spill, the OSC shall submit to the RRT a complete report on the response operation and the actions taken. A copy of this report will be submitted to the National Response Team. The format for this report is provided in the National Contingency Plan.

Each OSC is responsible for developing and updating local contingency plans. Each plan should be a multi-agency effort involving all agencies that would have a role in the local response effort.

2.7 National Strike Force (NSF)

The National Strike Force (NSF) was formed in 1973 after the U.S. Coast Guard was charged with oversight and responsibilities for offshore oil spills under the Federal Water Pollution Control Act. The NSF consists of the Pacific and Atlantic Area Strike Teams. These teams provide experienced personnel and equipment necessary for assisting the OSC in responding to spills in U.S. waters. The NSF is always on call and maintains a stock of specialized equipment for deployment anywhere in the Nation and, in some cases, overseas. This equipment includes open water oil containment and recovery systems, high capacity pumps for transferring oil and chemicals, and protective clothing for working with hazardous materials. Most of this equipment is designed to fit into Coast Guard C-130 cargo planes or load onto flat bed trucks for fast response. A description of the major equipment items maintained by the National Strike Force is provided in Section 4.

The Pacific Area Strike Team is based in San Francisco, California. A minimum of four team members can be dispatched and at the spill site in Alaska within four to six hours after notification. Additional members of the strike team can be on-site within 12 hours.

2.8 State of Alaska Contingency Plan

The Alaska Department of Environmental Conservation (ADEC) has prepared a contingency plan to coordinate federal, state, and local government activities for responding to oil and hazardous substance spills in Alaska. This plan also establishes the Alaska State Spill Response Team which is comprised of ADEC personnel who are trained for oil spill cleanup. Each ADEC regional office and the central office has individuals who are assigned to this team. The state's spill response team can perform oil spill containment, recovery, communication, and disposal techniques. It is responsible for on-site surveys, deployment, sampling, cleanup, and containment, as well as hazardous substance spill response.

The State On-Scene Coordinator (OSC) is responsible for:

- site specific response operation and monitoring cleanup activities for the state.
- activating the State Spill Response Team and providing it with appropriate information on the spill.
- coordinating the efforts of local and state agency resources.
- facilitating communication and transportation.
- identifying the spiller and probable cause.
- providing public information.
- documenting evidence including witness statements.
- coordinating state activities for federal action.
- estimating potential hazards created by the spill.
- notifying state agencies and determining response requirements.

The State OSC bears the brunt of the responsibility for state cleanup and monitoring. In a situation which does not require full activation of the State Response Team, but does require cleanup beyond the capability of the spiller, the State OSC has the authority to employ and supervise private contractors for oil spill cleanup recovery and disposal.

3.0 INITIAL RESPONSE

The initial response to an oil spill in the Beaufort Sea will play a key role in determining the magnitude of the cleanup operation and the spill's impact on the environment. For all spills, the initial response should entail the following steps: 1) stop the spill and report it to the appropriate agencies, 2) contain the spill to minimize spreading, and 3) remove the spill from the water surface.

Two factors govern the success or failure of the initial response operation, i.e., elements of response and environmental conditions. Elements of response are defined as the personnel, equipment and logistics necessary for conducting an oil spill response operation. Correctly identifying which elements of response would be effective for a given spill is the first step for ensuring that the response operation will be successful. The next step is to implement them.

In the Beaufort Sea, environmental conditions dictate when or if the elements of response can be implemented. These conditions have a strong influence over the initial response because they allow or deny access to the spill site and determine the extent to which specific elements of response will be effective.

This chapter of the Planning Guide will discuss various elements of response as they relate to an initial response operation under typical Beaufort Sea conditions. The objective of this section is to help the On-Scene Coordinator understand when and where existing response options are likely to be effective. To date there has never been an actual or experimental oil spill offshore in the Alaskan Beaufort Sea. Therefore, the information presented in this section is based on spills which have occurred in other areas of the world and input from oil spill consultants in Alaska.

A comprehensive discussion of the elements of response is provided in Section 4 and the Appendices. Decision trees and checklists for oil spill response operations are provided in Section 6.

3.1 Sources and Timing for Beaufort Sea Oil Spills

Drilling operations and fuel barges are currently the only sources for offshore oil spills in the Alaskan Beaufort Sea. Another possible source would be oil entering U.S. waters from a Canadian tanker spill. As noted in Table 3.1, regulatory stipulations and ice conditions generally limit spill sources to either: 1) the winter when solid ice and low temperatures would restrict oil spills to small areas or 2) the open water season where spills can be contained and cleaned up.

Table 3.1

PERIODS WHEN BEAUFORT SEA
OIL SPILLS CAN OCCUR

Potential Spill Source	Distance[1][2] From Shore	Periods When Spill Can Occur	Sea Condition
Gravel Island	3 mi.	November to Mid-May	Solid Ice
		Late July to Mid-September	Open Water
Ice Island	3 mi.	November to Mid-May	Solid Ice
Single Steel Drilling Caisson	3 mi.	November to Mid-May	Solid Ice
		Late July to Mid-September	Open Water
Concrete Island[3] Drilling System	3 to 20 mi.	November to Mid-May	Solid Ice
Drillship	3 to 30 mi.	Late July to Late October	Open Water/ Broken Ice
Fuel Barge	3 mi.	August	Open Water

Notes:
1. Potential spill sources 3 miles or less from shore are in state waters where exploration is restricted during the broken ice season.
2. Potential spill sources more than 3 miles from shore are in federal waters. Ice conditions in general dictate when drilling can occur.
3. This structure can operate during any season, but is usually shut-down for relocation during the broken ice and open water seasons.

Under certain conditions where the Operator complies with additional oil spill contingency planning criteria established by the State of Alaska, drilling may be allowed during the broken ice season. To date there have been very few offshore drilling operations during this season.

As previously noted, fuel barges are also sources for oil spills in the Beaufort Sea. Currently, fuel is barged to three coastal villages (Barrow, Kaktovik and Wainwright) during August of each year. At each location, fuel is pumped from the barges to onshore storage tanks. It is conceivable that spills could result from faulty connections, line ruptures, or equipment failure during the transfer operations. Spills could also result from village tank farms which are usually within 2,000 to 3,000 ft. of the shore.

3.2 Response Considerations for Spills Which Could Occur

Based on the information presented in Section 3.1, the following types of spills are conceivable for the Beaufort Sea:

Type of Spill	Spill Size (Bbls)	Sea Conditions
Fuel Spill	1,000	Solid Ice/Open Water
Surface Blowout	1,000/day	Solid Ice/Open Water
Surface Blowout	1,000/day	Breakup
Subsea Blowout	1,000/day	Open Water

Due to the current level of drilling activity during breakup, it is highly unlikely that a blowout will occur during this season. However, drilling activities in state waters during breakup could increase if commercial quantities of hydrocarbons are discovered.

Initial response considerations for the spills which could occur are discussed in the following sections and summarized in Table 3.2.

3.2.1 Fuel Spills

Spills during commercial fuel transportation and transfer operations may present the only scenario where the On-Scene Coordinator might be required to initiate the response operation. If this should occur, the following steps are suggested:

- Stop the Spill. If the spill is from a damaged barge, fuel from the leaking compartment should be off-loaded as soon as possible. In some cases, this can be accomplished by transferring the fuel into another compartment in the barge. When this is not possible and no provisions

Table 3.2

INITIAL RESPONSE

FOR

BEAUFORT SEA BLOWOUTS AND OIL SPILLS

Type of Spill	Solid Ice	Breakup	Open Water	Freeze-up
Fuel Spill	Seal Leaking Container or Off-load Fuel	Seal Leaking Container or Off-load Fuel	Seal Leaking Container or Off-load Fuel	Seal Leaking Container or Off-load Fuel
	Clean up Oiled Snow and Ice With Hand Tools or Front-end Loader	Deploy Boom to Contain Spill If Ice Conditions Permit	Deploy Boom to Contain Spill	Clean up Oiled Snow and Ice With Hand Tools
Surface Blowout	Shut Well In With Surface Techniques	Ignite Well	Ignite Well	Ignite Well
	Evacuate Coastal Villages if Threatened By Toxic Materials From Blowout	Shut Well In With Surface Techniques	Shut Well In With Surface Techniques	Shut Well In With Surface Techniques
		Use Air Deployable Ignitors For In-Situ Burning	Deploy Boom Around Blowout	
		Evacuate Coastal Villages If Threatened By Toxic Materials From Blowout	Mobilize Skimmers and Response Barges	
			Consider Dispersants	
			Evacuate Coastal Villages if Threatened By Toxic Materials From Blowout	

Table 3.2 (Continued)

INITIAL RESPONSE

FOR

BEAUFORT SEA BLOWOUTS AND OIL SPILLS

Type of Spill	Solid Ice	Breakup	Open Water	Freeze-up
Subsea Blowout	N/A	N/A	Relocate Drill-ship and Spud Relief Well Deploy Boom to Contain Spill Mobilize Skimmers and Response Barges Consider Dispersants	Relocate Drilling Vessel and Deploy Ignitors to Burn Oil

are available for off-loading the barge, it should be surrounded with a boom. While this is in progress, a barge should be mobilized from Prudhoe Bay for the off-loading operation. Most points in the transportation corridor between Barrow and Kaktovik can be reached from Prudhoe Bay by marine vessels in 10 to 12 hrs. during the open water season.

- Contain the Spill. As soon as the On-Scene Coordinator (OSC) is notified that a spill has occurred and no one has assumed responsibility for it, it would be appropriate for the OSC to request oil spill cleanup contractors to deploy a boom around the leaking barge.

  During the open water season, average wind speeds in the Beaufort Sea region range from 10 to 15 knots. Based on data provided by the Beaufort Scale of Wind Force, these wind speeds will generate waves which range from 2 to 3 ft. In view of this, the Kepner Reelpak Boom and the Goodyear Sea Sentry Boom are two of the booms which would be suitable for this sea state. These booms are stockpiled by Alaska Clean Seas (ACS) at its Prudhoe Bay warehouse and can be leased by the Coast Guard for spill response.

  The Kepner Reelpak Boom is much easier to deploy. It is self-inflating and can be rapidly transported to the spill site by the ACS "North Star" workboat. The North Star can also be used to deploy this boom around the leaking barge.

- Oil Spill Cleanup and Storage. Rope mop and weir skimmers can be used to recover the spilled fuel. These skimmers can be transported to the spill site by helicopters, workboats, or barges. They can be deployed from the North Star or the decks of barges. Recovered oil can be stored in the same vessel which was used to off-load the leaking barge.

  In-situ burning may not be effective for thin oil films which have drifted downwind of the leaking barge. Although dispersants such as Corexit 9527 and Corexit 9550 might be effective for removing this oil from the water surface, it is unlikely that dispersant approval could be obtained before evaporation and natural dispersion remove the spill from the water surface.

- Manpower and Equipment Requirements. Up to four persons will be needed for boom deployment and initial spill cleanup. Along with this, a four-person crew will be needed to mobilize a tug and barge and conduct the off-loading operation. A helicopter operator and one person for monitoring the spill will also be required.

Equipment requirements will include at least one rope skimmer, one weir skimmer, 1,000 ft. of boom, one portable centrifugal pump, and one survival suit for each person participating in the cleanup and transfer operation. These items can be leased from the ACS equipment inventory at Prudhoe Bay. In addition to a tug and barge for the off-loading operation, one helicopter and one workboat will be needed. Additional helicopters should be on standby to evacuate persons at the spill site. General guidelines for initial equipment mobilization are provided in Table 3.2.1.

- <u>Potential Problems and Limitations</u>. Poor weather or reduced visibility can significantly limit or delay the response operation. During the open water season, dense fog can exist 25 percent of the time. Also, storms with winds in excess of 30 knots can occur during late August and September.

  For the Beaufort Sea, open water is defined as water which has less than 20 percent broken ice. However, ice concentrations during the open water season will depend on wind speed and direction. In view of this, it is possible for the spill site to contain far more than 20 percent broken ice. If this should occur, the potential for successful containment and cleanup will be limited. During good visibility, heavy concentrations of broken ice will not limit the off-loading operations for leaking barges.

3.2.2 <u>Surface Blowouts</u>

In accordance with criteria established by state and federal agencies, the initial response for a surface blowout will be implemented by the Operator. This response will entail the following actions:

- Evacuate personnel.
- Shut down or extinguish ignition sources.
- Implement well control procedures.
- Implement oil spill countermeasures.

Since requirements are in place to ensure that the Operator assumes responsibility for the blowout, it is reasonable to believe that the On-Scene Coordinator's (OSC) role may be limited to monitoring the response operation. The following sections identify considerations and decisions for surface blowout response in the Beaufort Sea.

Table 3.2.1

GENERAL GUIDELINES FOR

INITIAL EQUIPMENT MOBILIZATION

OIL SPILL RESPONSE CONSIDERATION	WINTER		BREAKUP		OPEN WATER		FREEZEUP	
	ITEM	QTY	ITEM	QTY	ITEM	QTY	ITEM	QTY
Containment	-	-	Fire Containment Boom	1,000 Ft.	Fire Containment Boom	1,000 Ft.	-	-
			Harbor Boom	2,000 Ft.	Harbor Boom	2,000 Ft.	-	-
Cleanup	Front End Loader	2	Rope Mop Skimmer	2	ARCAT Skimmer	1	Rope Mop Skimmer	2
	Snow Shovels	10	Weir Skimmer w/Pump	2	Rope Mop Skimmer	2	Weir Skimmer w/Pump	2
	Suction Pump	2	ARCAT Skimmer	1	Weir Skimmer w/Pump	2	Ice Auger	2
Storage	Storage Tanks or Bladders	5	Barge	1	Barge	1	Storage Tanks or Bladders	5
					Dracone Barge	2		
Disposal	-	-	Air Deployable Ignitors	50	Air Deployable Ignitors	50	Air Deployable Ignitors	50
			Portable Burner	1	Portable Burner	1	Portable Burner	1
Transportation	C-130	1	Helicopter (10-passenger)	2	Helicopter (10-passenger)	2	Boeing Vertol 107 II (or similar aircraft)	1
	Helicopter (10-passenger)		Tug (Ice Strengthened)	1	Tug	1	Bell 212	2

Table 3.2.1 (Continued)

GENERAL GUIDELINES FOR

INITIAL EQUIPMENT MOBILIZATION

OIL SPILL RESPONSE CONSIDERATION	WINTER	BREAKUP	OPEN WATER	FREEZEUP
	QTY	QTY	QTY	QTY
Support Equipment				
Lights	4			4
Generators	4	4	4	4
Shelters	2	2	2	2
Response Boxes	5	3	3	2
Boats	-	2	2	-
- 16'Jon	-	2	-	-
- 21' Munson	-	-	2	-
- North Star	-	-	1	-
Portable Radios	12	7	8	5
Life Support Packages	5	3	3	2

Sources for Response Equipment:

1. Front End Loader - Kodiak (659-2648) or Frontier (659-2565)
2. Tugs/Barges - Kodiak (659-2648) or Crowley (349-8551)
3. Aircraft - ERA (659-2465) or Evergreen (659-2457)
4. Other Equipment - ABSORB (659-2405)

3.2.2.1 Well Control

Once a blowout occurs, it will continue until it is stopped by well control techniques, reservoir depletion, or downhole erosion (well plugging by sand, shell or earth). As soon as environmental conditions allow, well control techniques should be initiated. In order of priority these techniques should entail: 1) using rig personnel to close the blowout preventers (BOP), if possible, 2) employing well control contractors to close the BOP or cap the well, or 3) drilling a relief well.

It is important to immediately determine whether the Operator has sufficient expertise to implement surface techniques for well control. If so, the Operator should be requested to provide a detailed plan which shows tasks and timing for shutting in the well. This plan should also include a critical path that shows when a relief well will be started and the steps for completing it.

If the operator does not have the capability to implement surface techniques, it would be appropriate for the OSC to recommend that a Well Control Contractor from the Lower-48 be employed for this purpose. If this Contractor determines that surface techniques will not be successful, the Operator should be encouraged to begin a relief well.

For bottom-founded drilling structures, such as gravel islands, the relief well decision will depend on whether the blowout preventer or surface casing is in place. If they are in place, it is likely that the blowout can be stopped in a few days by surface techniques. On the other hand, if they have been ejected by the blowout, it is conceivable that a relief well will be required. Regardless of which well control techniques are used, the OSC should request the Operator to provide justification for them and evaluate alternatives.

3.2.2.2 Well Ignition

Depending on weather, 45 days or more may be required to complete a relief well in the Beaufort Sea. During this time, thousands of barrels of oil could be released to the environment. As a result, both the State of Alaska and the Petroleum Industry view well ignition as a technique for limiting the amount of oil released by a blowout.

Well ignition is the process of using a flare or other incendiary device to set a blowing well on fire. Following this, the well will be allowed to burn until it is shut-in. Although most oil spill contingency plans cite well ignition as a primary response technique, no uniform criteria outlining the timing and strategy for it exists. For example, some contingency plans state that the well ignition decision will depend on:

- o The probability of controlling the well with surface techniques.
- o Potential environmental damage which could result if the well is not ignited.
- o Potential environmental damage which could result if the well is ignited.
- o Oil spill cleanup costs with and without ignition.

While well ignition may prevent 75 to 95 percent of the oil from a surface blowout from reaching the water, it will create a tremendous quantity of black smoke and particulate matter. With respect to environmental impact, this may deteriorate existing air quality and violate ambient air quality standards established by the Federal Clean Air Act.

The well ignition decision is a complex process which requires careful consideration by the Operator, OSC, and state and federal agencies responsible for air and water quality and wildlife management. Additionally, input will probably be provided by local communities. To say the least, several days may be required to reach a decision.

To expedite the decision process for well ignition, it would be appropriate for the OSC to request the Alaska Regional Response Team to form a task group to address issues and concerns associated with well ignition.

3.2.2.3 Winter Blowouts

For winter blowouts, the initial response should focus on well control. Since solid ice and low temperatures will minimize spill spreading, it may be possible to delay the oil spill cleanup operation until the well is controlled. If breakup will begin before the blowout is stopped, consideration should be given to igniting the well.

Atmospheric inversions (weather conditions where temperature increases with altitude and holds pollutants close to the ground) frequently occur during the winter. Therefore, toxic gases released by either a blowing or burning well could adversely affect human health. Therefore, respiratory protection is recommended for all persons working near a blowout.

3.2.2.4 Breakup Blowouts

During the initial phase of breakup, ice will prevent the oil from spreading. Therefore, the initial response should be directed towards surface techniques for well control. If these techniques are not successful, it may be appropriate to consider well ignition. The primary reason for this is that ice conditions could delay a relief well for several months.

3.2.2.5 Open Water Blowouts

During the open water season, oil spills in the Beaufort Sea will rapidly spread. Consequently, the initial response should focus on well control and spill containment. If safety conditions allow, a heavy duty fire containment boom should be deployed around the drilling site. Currently, 2,500 ft. of fire containment boom is located in Alaska Clean Seas' Prudhoe Bay warehouse and could be used for this purpose.

Because of hazards to personnel, no attempts should be made to deploy a boom near a blowout if the combustible gas concentration is greater than 25 percent of the lower explosibility limit within 1/2 mile of the blowout site or if the wind speed is less than 5 knots. Due to the possible presence of toxic gases, personnel working at or near the blowout site should wear respiratory protection.

Due to the potential hazards created by combustible and toxic gases, the Operator should make all decisions regarding well control and spill containment at the drilling site. If the Operator does not assume responsibility for the blowout, the OSC should employ a Well Control Contractor to supervise and carry out operations at the drilling site.

If the decision is made to ignite the well, work should be implemented to contain and burn oil downwind of the blowout site. If the well is not ignited, Alaska Clean Seas' self-propelled skimming vessel "ARCAT Skimmer" and several barges equipped with portable skimmers should be deployed for spill containment and cleanup. To maximize safety, these vessels should remain at least 1/2 mile downwind of the blowout.

3.2.2.6 Subsea Blowouts

Blowouts from drillship operations will probably occur below the water surface. To protect the drillship and its crew, the initial response for this type of blowout would be to release the anchor lines and move off location. Following this, steps should be implemented to drill a relief well. Also, the gases escaping from the water should be ignited to remove the potential for personnel exposure to toxic fumes.

Fire containment boom should be deployed in a U-shaped catenary downstream of the blowout site. Each end of the boom should be attached to an ice-strengthened tug boat and slowly moved as the wind changes, so that the apex will always be downstream of the thickest portions of the spill. Air deployable ignitors can be dropped from helicopters to initiate in-situ burning. Since the tug boats will be upstream of the burning oil, the crew will not be affected by the smoke plume.

3.2.2.7 Dispersants

Dispersants are chemicals which lower the interfacial surface tension between oil and water. This makes it possible for wave energy to break an oil spill into tiny droplets and disperse them into the water column.

During the open water season, it would be appropriate to consider dispersants as an initial response for large spills that threaten wildlife habitats or endangered wildlife species. Two situations which may warrant dispersant use are: 1) a large spill in the bowhead whale migration corridor during late August and early September and 2) oil slicks threatening a shoreline containing a large bird population.

Prior to committing to dispersant use, the following questions should be answered:

- Will the dispersant effectively remove the oil from the water surface?
- Will existing currents prevent subsurface oil plumes from entering shallow near-shore waters?
- Can dispersants be deployed before the oil weathers or contacts wildlife resources or areas threatened by the spill?

If the answer to each question is positive, it would be appropriate for the OSC to request dispersant use approval from the Alaska Regional Response Team.

It should not be arbitrarily assumed that dispersants will be effective. Each crude oil is different. Therefore, dispersants which may be effective for crude oil "A" may not be effective for crude oil "B". Based on existing data, it is unknown if any dispersants would be effective in the Beaufort Sea. The reason for this is that dispersant effectiveness is related to water temperature and salt concentration. When these variables are low, dispersant effectiveness is also low. Therefore, it is questionable if existing dispersants would be effective in Beaufort Sea areas containing melting ice or river drainage.

Currently, 400 barrels of Corexit 9527 are stored in Alaska. At one part dispersant to 20 parts oil, this quantity of dispersant is sufficient to treat an 8,000 barrel oil spill. Equipment for dispersant deployment can be obtained from Alaska Clean Seas.

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4.0 ELEMENTS OF RESPONSE

Elements of response can be defined as the equipment, personnel, and logistics necessary for responding to an oil spill. A good understanding of these elements, including their capabilities and limitations is essential for conducting a successful oil spill cleanup operation.

This section of the Planning Guide provides a detailed discussion of the elements of response currently available in Alaska. Its objective is to acquaint the On-Scene Coordinator (OSC) with these elements and explain how they can be used for oil spill response in the Beaufort Sea.

This section was prepared in consultation with Oil Spill Consultants and Contractors who have a thorough working knowledge of the state-of-the-art for arctic oil spill response. It provides a realistic overview of existing response capability and limitations. After reading this information, the OSC will be able to discern if a specific response element is suitable for the circumstances that he may be confronted with.

Due to the tremendous effort which has been put forth by the Oil and Gas Industry, sufficient equipment is currently stockpiled in Alaska to control and clean up offshore spills consisting of thousands of barrels of oil. For example, Alaska Clean Seas (an industry sponsored oil spill co-op) has more than 5 million dollars worth of response equipment to support offshore exploration in Alaska. In addition to this, the Alyeska Pipeline Service Company also has a very large equipment inventory for oil spill response in Alaska.

The response equipment owned by co-ops and Oil Spill Cleanup Contractors in Alaska is listed in Table 4.0.1. Although this equipment is privately owned, it can be leased by the OSC for spill response in the Beaufort Sea. Table 4.0.2 identifies oil spill response equipment owned by the Pacific Strike Team and co-ops in California and Canada. Additional information on existing response equipment is provided in the Appendices.

Even though sufficient equipment and logistical resources are available in Alaska, the OSC should be advised that environmental conditions, trained personnel, and recovered oil disposal capability are factors which could limit oil spill response capability for the Beaufort Sea. Figure 4.0 summarizes the applicability of existing elements of response for the Beaufort Sea.

(Page numbers for specific elements of response are provided in the Table of Contents beginning on Page vi.)

Figure 4.0
ELEMENTS OF RESPONSE SEASONAL APPLICABILITY

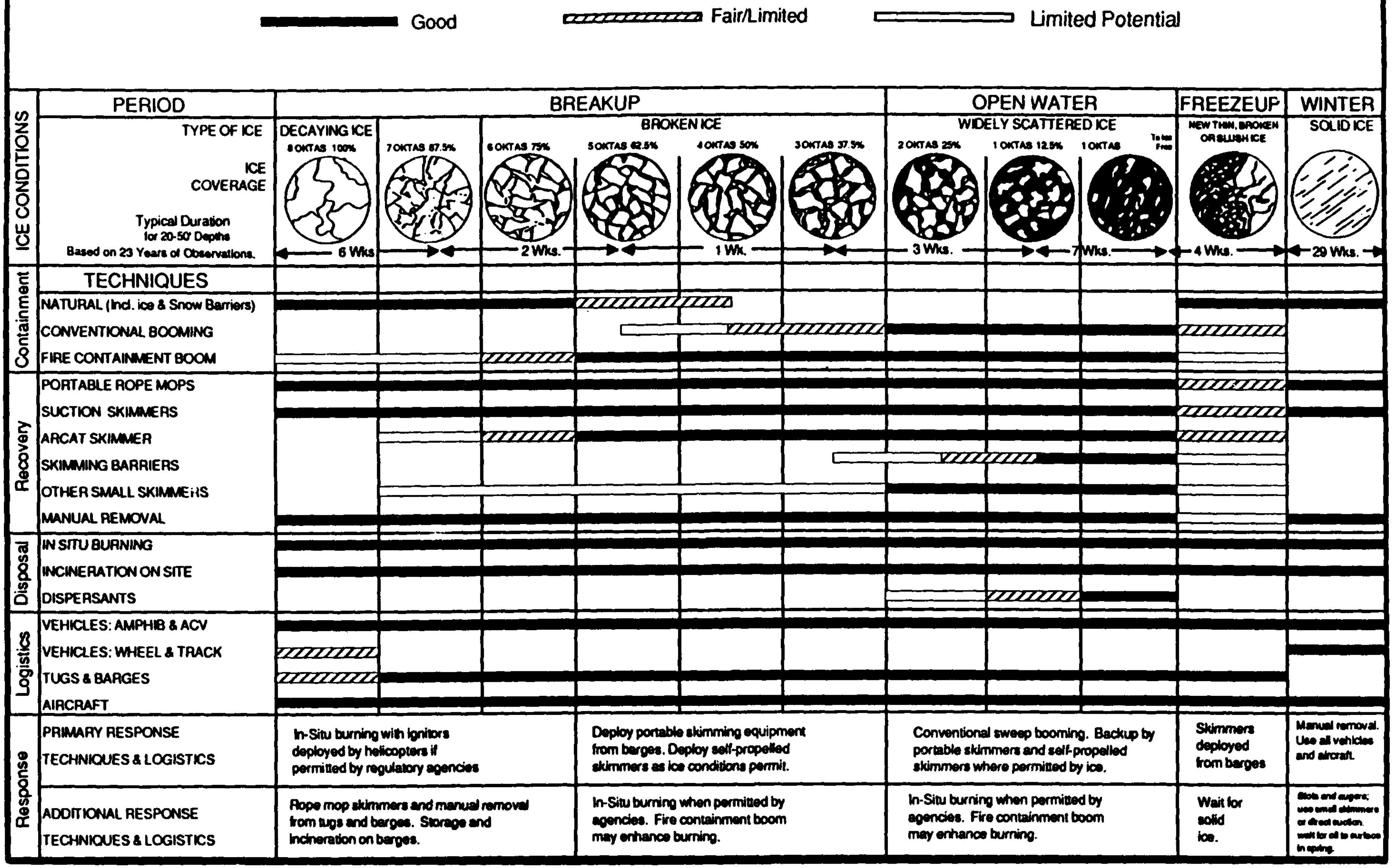


Table 4.0.1

SUMMARY OF OIL SPILL
RESPONSE EQUIPMENT IN ALASKA

Equipment Owner/Quantity

	Equipment	Unit	Ajit Shah Inc. 344-2625	Alaska Clean Seas 345-3142	Alaska Offshore 349-4578	Alyeska Pipeline Service Co. 265-8174	Cook Inlet Response Organization 349-7412	Crowley Environmental Service Corp. 344-1511	Unitech of Alaska 349-5142	U.S. Coast Guard 271-5137 487-570
1.	Boom									
	Acme Corral	ft.		3,000						
	American Marine Simplex	ft.		3,000						
	Aqua Fence	ft.					1,000			
	Curtain Type	ft.				15,500				
	Expandi	ft.	6,800							
	Fire Containment	ft.		2,500						
	Goodrich									9,000
	Goodyear Sea Sentry	ft.		2,035						
	Kepner Reel Pak	ft.		4,000				6,700		1,000
	Pedico EPI Mini	ft.		3,000						
	Kepner-B142408FF	ft.								1,000
	Ocean Dike	ft.		5,400						
	Seaboom					4,800				
	Vikoma SeaPak					7,250	1,450			
	Whittaker Expandi	ft.		4,500				1,000		
	Compactible Boom									
	4"x6"	ft.			900				600	
	10"x20"	ft.			2,500					
	Standard Boom	ft.			2,000					
	Performance Boom	ft.							1,200	
	Compactible Boom-12	ft.							400	

Table 4.0.1 (Continued)

SUMMARY OF OIL SPILL
RESPONSE EQUIPMENT IN ALASKA

Equipment Owner/Quantity

Equipment	Unit	Ajit Shah Inc. 344-2625	Alaska Clean Seas 345-3142	Alaska Offshore 349-4578	Alyeska Pipeline Service Co. 265-8174	Cook Inlet Response Organization 349-7412	Crowley Environmental Service Corp. 344-1511	Unitech of Alaska 349-5142	U.S. Coast Guard 271-5137 487-570
2. Skimmers									
Belt									
- Marco Class I	each				1				
- Marco Class V	each				1				
- Marco Class VII	each				1				
Disc									
- Komara	each	2				1			
- MI-30	each		1						
- Vikoma	each								
Drum									
- Lockheed 3100	each					1			
- Lockheed 110	each								1
Rope Mop									
- ARCAT Skimmer	each		1						
- Barracuda	each		1						
- MW62	each		2						
- Z-14E	each		10			4			
- MKII4-E	each			4			2	2	
- MW41	each								

Table 4.0.1 (Continued)

SUMMARY OF OIL SPILL
RESPONSE EQUIPMENT IN ALASKA

Equipment Owner/Quantity

Equipment	Unit	Ajit Shah Inc. 344-2625	Alaska Clean Seas 345-3142	Alaska Offshore 349-4578	Alyeska Pipeline Service Co. 265-8174	Cook Inlet Response Organization 349-7412	Crowley Environmental Service Corp. 344-1511	Unitech of Alaska 349-5142	U.S. Coast Guard 271-5137 487-570
2. Skimmers (Cont'd)									
Vacuum/Suction									
- Transvac	each		2		1				
- Sock	each		1	4					
- Scavenger	each								
- Vac-U-Max	each				4				
Vortex									
- Cyclonet 070	each					1			
- Cyclonet 120	each					1			
Weir									
- Acme	each		2						
- Halliburton Fast Response Unit	each		1						
- Halliburton Skimming Barrier	each		1						
- Manta Ray	each		2	2	2		2	3	
- SkimPak	each							2	
- Slurp	each		10					1	
- Walosep	each	2	1						
3. Sorbent									
- Bales	Bales		111				5,000		
- Blankets	ft.				150	560			
- Boom	ft.		14,800		5,000		7,000	14,000	

Table 4.0.1 (Continued)

SUMMARY OF OIL SPILL
RESPONSE EQUIPMENT IN ALASKA

Equipment Owner/Quantity

	Equipment	Unit	Ajit Shah Inc. 344-2625	Alaska Clean Seas 345-3142	Alaska Offshore 349-4578	Alyeska Pipeline Service Co. 265-8174	Cook Inlet Response Organization 349-7412	Crowley Environmental Service Corp. 344-1511	Unitech of Alaska 349-5142	U.S. Coast Guard 271-5137 487-570
3.	Sorbent (Cont'd)									
	- Pads	Bales		669					612	119
	- Rolls	Rolls		548				2,000	320	52
	- Sheets	Boxes	400	85		100				
	- Sweeps	each						180		
4.	Pumps									
	Centrifugal	each		14	8	3	1	3	2	
	Diaphragm									
	- Fuel Powered	each		10	2	2	2	2		
	- Air Operated	each		9						
	- Hand Operated	each				1		2		
	Destroil	each		1						
	Sludge Pump	each								
	- Air Operated	each		9						
	- Submersible	each			1					
5.	Transfer Hose									
	Suction									
	- 6 in.	ft.				50				
	- 4 in.	ft.				200		80		
	- 3 in.	ft.	700	5,420	600	100	50	60		
	- 2 in.	ft.	1,000	1,620	500		50			

Table 4.0.1 (Continued)

SUMMARY OF OIL SPILL
RESPONSE EQUIPMENT IN ALASKA

Equipment Owner/Quantity

Equipment	Unit	Ajit Shah Inc. 344-2625	Alaska Clean Seas 345-3142	Alaska Offshore 349-4578	Alyeska Pipeline Service Co. 265-8174	Cook Inlet Response Organization 349-7412	Crowley Environmental Service Corp. 344-1511	Unitech of Alaska 349-5142	U.S. Coast Guard 271-5137 487-570
5. Transfer Hose (Cont'd)									
Discharge									
- 6 in.	ft.				300				
- 4 in.	ft.		400		200		200		
- 3 in.	ft.		5,200	3,500	200	50	150	600	
- 2 in.	ft.			1,800		50			
6. Storage Containers									
Bladders									
- 50,000	gallon			6					
- 25,000	gallon		2						
- 1,000	gallon			2					
- 5,000	gallon						1		
- 4,400	gallon		4						
- 2,500	gallon			2				2	
- 2,250	gallon		20						
- 1,000	gallon				1				
- 500	gallon	50			1				
Dracone Barge	2,500 gallon		6						
Drums									
- 85	gallon		6		50			180	4
- 55	gallon						232		10

Table 4.0.1 (Continued)

SUMMARY OF OIL SPILL
RESPONSE EQUIPMENT IN ALASKA

Equipment Owner/Quantity

	Equipment	Unit	Ajit Shah Inc. 344-2625	Alaska Clean Seas 345-3142	Alaska Offshore 349-4578	Alyeska Pipeline Service Co. 265-8174	Cook Inlet Response Organization 349-7412	Crowley Environmental Service Corp. 344-1511	Unitech of Alaska 349-5142	U.S. Coast Guard 271-5137 487-570
6.	Storage Containers (Cont'd)									
	Tanks									
	- 9,000	gallon			1					
	- 4,570	gallon					2			
7.	Boats									
	ARCAT Skimmer	each		1						
	Jon Boats	each		7		2				
	Rubber Boats	each		3	2		2	2		
	Workboats	each	1			5		4		
	Tug Boats	each				3				
8.	Chemical Agents									
	Dispersants	drums	6	200		50	209			
	Collectants	drums		5			1			
9.	Chemical Agent Equipment									
	ARCAT Skimmer	each		1						
	Helicopter Spray Unit	each		2			2			
	Ship Spray Unit	each		1						
	Hand Spray Unit	each		3						

Table 4.0.1 (Continued)

SUMMARY OF OIL SPILL
RESPONSE EQUIPMENT IN ALASKA

Equipment Owner/Quantity

	Equipment	Unit	Ajit Shah Inc. 344-2625	Alaska Clean Seas 345-3142	Alaska Offshore 349-4578	Alyeska Pipeline Service Co. 265-8174	Cook Inlet Response Organization 349-7412	Crowley Environmental Service Corp. 344-1511	Unitech of Alaska 349-5142	U.S. Coast Guard 271-5137 487-570
10.	Disposal Equipment									
	Air Deployable Ignitors	each		1,700						
	Clean Fire Portable Incinerator	each		1						
	Trecan Portable Incinerator	each		1						
	Flare Burner	each		1						
11.	Communication Equipment									
	Command & Communications Modules/Vans	each		5						
	VHF Base Station						1			
	Telephone Sets	each		8						
	UHF Base Station	each			1			2		
	Communications Network and repeater	each		2						
	Compco Air-Ground	each		1						
	10 Station PBX System	each		1						
	SSB Base Station	each		3	1					
	Handheld Radio									
	- UHF	each		32	4					
	- VHF	each		5	4		8	8		
	GE Hand Carry Porta Mobil	each		3						
	GE Electric Mastr II	each		5						

Table 4.0.1 (Continued)

SUMMARY OF OIL SPILL
RESPONSE EQUIPMENT IN ALASKA

Equipment Owner/Quantity

Equipment	Unit	Ajit Shah Inc. 344-2625	Alaska Clean Seas 345-3142	Alaska Offshore 349-4578	Alyeska Pipeline Service Co. 265-8174	Cook Inlet Response Organization 349-7412	Crowley Environmental Service Corp. 344-1511	Unitech of Alaska 349-5142	U.S. Coast Guard 271-5137 487-570
12. Support Equipment									
Air Compressors	each		2		2		2		2
Generators	each		19	7		2	4		
Lanterns/Batteries	each				25				
Portable Light Plants	each		13	2	4				
Heaters	each		18	3			5		
Shelter									
- Portable Base Camp	each		1						
- Weather Ports	each		13	2					
- 4-Man Tent	each			3					
Shovels	each				12				
Rakes	each				2				
Pitch Forks	each				2				
Weed Burners	each			6	1				
MSA Air Packs	each		5	3		3			
Mustang Float Coats	each		60						
Survival Suits	each		85						
Life Vests	each		72						
Ice Auger	each			2					

Table 4.0.1 (Continued)

SUMMARY OF OIL SPILL
RESPONSE EQUIPMENT IN ALASKA

	Equipment	Unit	Ajit Shah Inc. 344-2625	Alaska Clean Seas 345-3142	Alaska Offshore 349-4578	Alyeska Pipeline Service Co. 265-8174	Cook Inlet Response Organization 349-7412	Crowley Environmental Service Corp. 344-1511	Unitech of Alaska 349-5142	U.S. Coast Guard 271-5137 487-570
			Equipment Owner/Quantity							
12.	Support Equipment (Cont'd)									
	Vehicles									
	- Van Truck	each		1	1					
	- Pickup Truck	each	3	1	2		1			
	- All Terrain Vehicle	each		1			1			
	- Snowmobile	each		2						
	- Passenger Van	each			1					
	- 5-Ton Flatbed	each						1		
	- Truck/Tractor	each		1				1		
	- Forklift	each		1				1		
13.	Detection									
	Orion Tracking System	each		2						

Notes: 1. Information for this table was obtained from the ACS Oil Spill Contingency Planning Manual and Cleanup Contractors in Alaska.

2. Additional containment and recovery equipment will be on each offshore drilling rig in operation.

Table 4.0.2

SUMMARY OF OIL SPILL
RESPONSE EQUIPMENT OWNED
BY PACIFIC STRIKE TEAM, CALIFORNIA CO-OPS
AND CANADIAN CO-OPS

Equipment	Unit	Pacific Area Strike Team (415) 883-3311	Clean Bay (415)685-2800	Clean Seas (805)965-6502	Clean Coastal Waters (213)833-4426	Canadian Beaufort Sea Oil Spill Co-op (403)977-7100
1. Boom						
American Marine			8,400			
Aqua Fence			500			
Bennett Arctic	ft.					2,400
Bennett - 18"	ft.					2,500
Bennett - 36"	ft.					1,000
Bottom Tension	ft.			2,000		
Expandi						
- 3000	ft.		1,600	5,527	15,000	
- 4300	ft.		2,000	10,600	4,000	
Goodyear	ft.			2,695	3,100	
Kepner - 8"	ft.			2,000		
Kepner - 14"	ft.				5,000	
Kepner - 16"	ft.		4,600	3,200		
Kepner - 20"					5,000	
Mini Max	ft.			5,500		
Navy - 36"	ft.					4,000
Sea Sentry	ft.			2,035		
Skimming Barrier	each	4				
Super Max - 36"	ft.			2,500		
Vikoma SeaPak	ft.				8,000	
2. Skimmers						
Belt						
- Marco I		1	2			
- Marco II					1	
- Marco III			2			

Table 4.0.2 (Continued)

SUMMARY OF OIL SPILL
RESPONSE EQUIPMENT OWNED
BY PACIFIC STRIKE TEAM, CALIFORNIA CO-OPS
AND CANADIAN CO-OPS

Equipment	Unit	Pacific Area Strike Team (415) 883-3311	Clean Bay (415)685-2800	Clean Seas (805)965-6502	Clean Coastal Waters (213)833-4426	Canadian Beaufort Sea Oil Spill Co-op (403)977-7100
2. Skimmers (Continued)						
Disc						
- MI-30	each					2
- Komara	each			1	2	
Drum						
- Lockheed R2003	each					1
- Lockheed 4000	each	1				
Rope Mop						
- MKII 4D	each		1	2	1	1
Suction						
- Vac-U-Max	each	1				
Vortex						
- Cyclonet 050				1	1	
- Cyclonet 100				1		
- Walosep W1	each		1		1	
- Walosep W3	each			2	1	
Weir						
- Acme		1		6	2	
- Destroil 210	each				1	
- Floating Weir	each			3		
- ODI Skimming Barrier	each			2		
- Slurp	each	1	2			

Table 4.0.2 (Continued)

SUMMARY OF OIL SPILL
RESPONSE EQUIPMENT OWNED
BY PACIFIC STRIKE TEAM, CALIFORNIA CO-OPS
AND CANADIAN CO-OPS

	Equipment	Unit	Pacific Area Strike Team (415) 883-3311	Clean Bay (415)685-2800	Clean Seas (805)965-6502	Clean Coastal Waters (213)833-4426	Canadian Beaufort Sea Oil Spill Co-op (403)977-7100
3.	Sorbents						
	- Bales	Bales					
	- Blankets	ft.					
	- Boom	ft.					
	- Pads	Bales					
	- Rolls	Rolls					
	- Sheets	Boxes					
	- Sweeps	each					
4.	Pumps						
	- Centrifugal	each	7				2
	- Diaphragm	each	3				
5.	Transfer House						
	- 6 in.	ft.					
	- 4 in.	ft.					
	- 3 in.	ft.					550
	- 2 in.	ft.					250
6.	Storage Containers						
	- Dracone Barges	each	6	1	3		
	- Fabric Drums	each	8				
	- Kepner 5K Bags	each		4	3		
	- Kepner 1.2K Bags	each		6			
	- M/V Recover	each			1		
	- Tide - Mar VII Barge	each		1			

Table 4.0.2 (Continued)

SUMMARY OF OIL SPILL
RESPONSE EQUIPMENT OWNED
BY PACIFIC STRIKE TEAM, CALIFORNIA CO-OPS
AND CANADIAN CO-OPS

Equipment	Unit	Pacific Area Strike Team (415) 883-3311	Clean Bay (415)685-2800	Clean Seas (805)965-6502	Clean Coastal Waters (213)833-4426	Canadian Beaufort Sea Oil Spill Co-op (403)977-7100
7. Boats						
- Anti-Pollution Barge	each					1
- Canmar Sea Truck	each					1
- Canmar Jet Boat	each					1
- Monarch - 21 ft.	each	1				
- Response Vessels - 130 ft.	each		2			
- Response Boats - 35 ft.	each			3		
- Response Boat - 34 ft.	each	2				
- Zodiac	each					1
8. Chemical Agents						
- Dispersant	drums	49	200	100		
- *Oil Herder*	drums	5				
9. Chemical Equipment						
- Dispersant System						1
10. Disposal Equipment						
- Vulcan Flareburner						1
11. Communication Equipment						
- Marconi DJ93 Radios	each					3
- Ray 55 Radios	each					6
- Motorola MX-350	each	22				
- Regency Polaris MT 7000	each	5				
- UN-I-COM	each	4				
- Telecopiers		2				

Table 4.0.2 (Continued)

SUMMARY OF OIL SPILL
RESPONSE EQUIPMENT OWNED
BY PACIFIC STRIKE TEAM, CALIFORNIA CO-OPS
AND CANADIAN CO-OPS

Equipment	Unit	Pacific Area Strike Team (415) 883-3311	Clean Bay (415)685-2800	Clean Seas (805)965-6502	Clean Coastal Waters (213)833-4426	Canadian Beaufort Sea Oil Spill Co-op (403)977-7100
12. Support Equipment						
- Air Compressors	each	4				1
- Generators	each	3				1
- Lanterns/Batteries	each	1				1
- Mobile Command Post	each	1				
13. Detection						
- Argos Buoys						4
- Orion Tracking System						1

4.1 DETECTION AND SURVEILLANCE

4.1.1 Introduction

Detection and surveillance are essential for an effective oil spill response operation. In general, oil spill detection is the process of recognizing that oil has been released to the environment. In many respects, detection along with reporting the spill to the U.S. Coast Guard or EPA is the first step for ensuring that the potential for environmental damage can be minimized.

Surveillance is the process of monitoring oil spill movement in order to: 1) identify areas and resources which could be impacted by drifting oil, 2) establish priorities and develop plans for the response operation, and 3) obtain data for defining logistical requirements and countermeasures for the oil spill response operation.

This section of the Planning Guide will discuss equipment and techniques which are currently available for oil spill detection and surveillance. It will also highlight prototype equipment which may improve the capability for oil spill detection and surveillance in the Beaufort Sea region.

4.1.2 Visual Detection and Surveillance

Visual surveillance can be used to detect and monitor oil spills in the Beaufort Sea. Most exploration sites and petroleum facilities are manned 24 hours a day. In accordance with federal requirements, oil spills which enter or threaten to enter navigable waters must be immediately reported to the U.S. Coast Guard. Facility operators are familiar with this requirement and have trained their personnel to report all spills. Afterwards, they will notify other agencies as required.

Although visual surveillance is relatively simple, it is not effective during darkness, fog, extensive cloud cover, or whiteouts. Additionally, visual surveillance may not be very effective for monitoring spills from the decks of vessels or aircraft. The reason for this is that cloud shadows, suspended sediment, floating seaweed, or submerged sand banks may resemble an oil slick if viewed from a distance.

Some of the problems associated with visual monitoring from vessels or aircraft can be resolved by placing brightly colored tracking buoys in a slick as soon as it is detected. Once deployed, these buoys will move with the oil slick and can be easily spotted during good visibility. These buoys are discussed in Section 4.1.4.1.

It should be recognized that oil slicks with specific gravities greater than 1 may float below the water surface or sink. This can occur if the oil's gravity is 14 degrees API or less, if the oil weathers, or if it mixes with sediment in the water. Whichever the case, it may not be possible to detect these slicks by visual surveillance.

4.1.3 Detecting Oil Under Ice

4.1.3.1 Light Emission

During 1981 the Alaskan Beaufort Sea Oil Spill Response Body (ABSORB) demonstrated that high intensity light can be used to detect oil under ice. To implement this technique, holes are cut through the ice and lights are placed beneath it. If oil is present, light emission through the ice will be reduced. Although this technique is effective, it is slow and labor intensive. As such, it is only practical for areas where the boundaries of a spill are known.

Equipment for implementing this technique can be obtained from the ABSORB warehouse at Prudhoe Bay (907/659-2405).

4.1.3.2 Ultrasound and Electronic Techniques

Canadian scientists have tested a number of techniques for locating oil under ice. So far, ultrasound appears to be the most promising. This technique works as follows:

> "A short pulse of ultrasound is transmitted into the ice. This pulse is reflected and mode converted at the interface between the ice and oil or water interface. The returning pulses, one a compressional wave and the other a shear wave, are recorded. The relative amplitudes of the returning waves will indicate the presence, or otherwise absence of oil."

During laboratory experiments at the Technical University of Nova Scotia, ultrasound was used to detect a 1 to 2 centimeter oil film under 80 centimeters of ice. However, work is needed to develop a portable system that is reliable under Arctic conditions.

The principle limitation inherent to ultrasound detection arises from the fact that the velocity of sound through oil and water are relatively similar. Consequently, a simple reflection measurement may not be sufficient to clearly indicate if oil is under ice.

During 1981, Exxon Production Research Company sponsored a study at Rice University (Houston, Texas) which proved that laser-

induced fluorescence can be used to detect oil under ice. This technique works as follows:

> "A laser beam is projected through the ice. If oil is under the ice, it will absorb a portion of the laser beam and emit fluorescent light which can be detected by electronic monitors on the ice surface."

During 1986, Alaska Clean Seas initiated a research project to develop equipment for testing this concept in the Beaufort Sea. If this work proves successful, Beaufort Sea field tests will be conducted during 1987.

Although ultrasound and electronic techniques appear to have a lot of potential for detecting oil under ice, additional work is needed to perfect them and develop equipment suitable for field deployment.

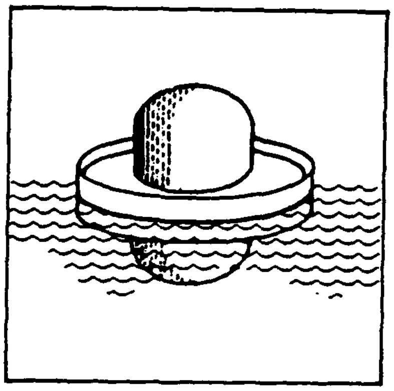
4.1.4 Aerial Monitoring

4.1.4.1 Radio-Transmitting Buoys

Since oil spills usually spread very rapidly and form wind rows that break into separate slicks, aerial surveillance is probably the best approach for spill monitoring. As noted in Section 4 1.2, visual surveillance is not always reliable for detecting oil slicks on water. To resolve this problem, Orion Electronics Ltd. (Saulnierville, Nova Scotia) and Novatech Designs, Ltd. (Victoria, British Columbia) developed tracking buoys which enhance oil spill monitoring by aerial surveillance (Figure 4.1.4.1). Both the Orion and Novatech buoys are coated with fluorescent orange paint and transmit radio signals which can be detected by portable equipment aboard aircraft. Once these buoys are placed in a slick, the radio signals will allow spill monitoring during periods of reduced visibility.

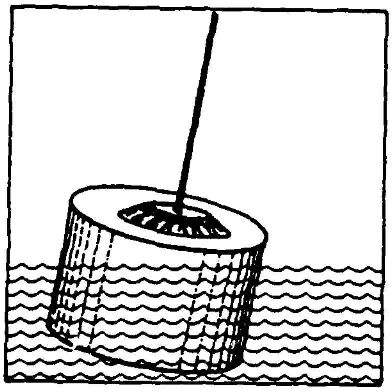
During October 1981, one Novatech buoy and two Orion buoys were tested in an experimental oil slick near St. Johns, Newfoundland. The results showed that the Novatech RF200 and the Orion 2100 remained with the oil slick throughout the experiment. The Novatech buoy was quickly coated with oil and was difficult to see from the air. The Orion 2100 was not coated with oil and was easy to find by visual surveillance. A summary of the data from this field test is provided in Table 4.1.4.1.

Alaska Clean Seas has three Orion 2100 tracking systems. Each system contains ten buoys and one radio receiver. Battery life and damage by moving ice are the primary limitations inherent to the Orion buoys. According to the manufacturer, the batteries have a two to three week operating life. Since these buoys are constructed from plastic, it is conceivable that they can be easily crushed by moving ice. As such, they may not be suitable for deployment in ice-infested water.



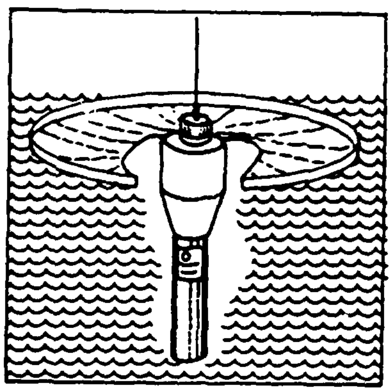
Orion 2100

Available in twelve frequencies from 150.800 MHz to 150.965 MHz in 15 khz steps.



Orion 4800

Available in twelve frequencies from 150.800 MHz to 150.965 MHz in 15 khz steps.



Novatech RF200

Available in a number of frequencies from 150.815 MHz in 30 khz steps.

Figure 4.1.4.1	OIL SPILL TRACKING BUOYS

Table 4.1.4.1

TEST RESULTS
FOR
RADIO TRANSMITTING BUOYS

Buoy	Test Date and Number	Movement from Centroid/Slick Movement (Metres)	Deviation (%)	Test Time (Hours)	Deviation (%) Per Hour	Total Average Deviation (%) Per Hour	Comments
Novatech RF200	Oct. 21-1	98/6,300	0.02	4.0	0.04	0.009	Buoy suitable for spill tracking.
	Oct. 22-1	28/1,700	0.02	3.4	0.005		
	Oct. 22-2	24/2,200	0.06	3.4	0.017		
Orion 2100	Oct. 21-1	98/6,300	0.15	4.0	0.038	0.04	Buoy suitable for spill tracking.
	Oct. 21-1	161/5,400	0.03	3.4	0.009		
	Oct. 22-1	454/1,700	0.27	3.4	0.079		
	Oct. 22-2	270/2,200	0.12	3.4	0.036		
Orion 4800	Oct. 21-1	-	-	-			Buoys not located, presumed to have deviated widely.
	Oct. 22-2	-	-	-			

Ref: Spill Technology Newsletter; November-December, 1981

4.1.4.2 USCG - Side-Looking Airborne Radar

The U.S. Coast Guard is developing an airborne real time, all weather, day/night remote sensing system that will detect oil slicks at sea. This system, called "Aireye", is scheduled to be installed on several of the Coast Guard's Falcon 20G jet aircrafts.

Aireye will include a side-looking airborne radar, a three channel infrared/ultraviolet line scanner, an aerial reconnaissance camera, an airborne data annotation system, and a control display and record console. To identify polluting vessels at night, an active gated television (AGTV) was developed for the Aireye. The AGTV uses a low power, pulse, gallium arsenide laser illuminator and is capable of recording vessel names at night from a slant range of 500 meters.

The side-looking airborne radar (SLAR) can produce good imagery in most weather conditions and is unaffected by clouds or darkness. Since the detection of oil slicks by this system depends on the dampening of capillary waves by oil, it can not detect slicks on flat, calm seas or very heavy seas. The SLAR will allow sweep widths up to 44 nautical miles for life rafts and small boats and up to 136 nautical miles for small cargo ships. SLAR will allow vast ocean areas to be searched for oil slicks and has a 90% reliability for slick detection. Once a target is detected it can be observed and recorded on video tape.

4.1.4.3 Swedish Coast Guard Side-Looking Airborne Radar

A multi-sensor, integrated oil spill and maritime surveillance system is now in use by the Swedish Coast Guard. This system, developed by the Swedish Space Corporations, includes second generation side-looking airborne radar (SLAR), infrared/ultraviolet (IR/UV) sensors, and a camera system. Sensor imagery provided by this system is presented on a television display.

The side-looking airborne radar (SLAR) has all weather capability and is designed to cover large areas and detect small targets. When installed on an aircraft, it is able to survey about 15,000 square kilometers per hour for oil spills and life boats, 30,000 square kms per hour for small fishing vessels, and 60,000 square kms per hour or 80 kilometers on each side of the aircraft for cargo ships.

Oil detection is possible because the SLAR is designed to observe level variations in sea clutter. An oil spill makes the polluted surface considerably smoother than the surrounding water. The smooth surface produces less radar back-scatter which makes the oil appear as a dark area on the radar display.

Infrared detection relies on the physical properties of the oil. When an oil slick is exposed to infrared radiation it looks somewhat colder than the surrounding water. The Swedish infrared system can detect oil during day or night. It also enables the user to monitor oil spreading and indicates relative oil thickness within the slick. With this information, cleanup operations can be directed for maximum efficiency.

The ultraviolet detection system is used only in daylight. It maps the entire area covered with oil. This is possible because oil has a higher reflectivity than water when exposed to ultraviolet light. This information, in conjunction with the data provided by the infrared system, increases the reliability of aerial monitoring.

4.1.5 Satellite Surveillance

4.1.5.1 Time Lapse Photography

Satellite imagery offers another possibility for monitoring oil spills in the Beaufort Sea, particularly during the broken ice season. Currently, the Geophysical Institute at the University of Alaska (Fairbanks, Alaska) has access to two satellites (Landsat 4 and Landsat 5) that can be used for this purpose. Due to overlapping orbits, these satellites can provide almost continuous coverage of the Beaufort Sea.

Both satellites are equipped with multi-spectral scanners which are capable of providing four black and white images. Three of the images provided by each satellite are in the visible range and one is in the near infrared range. By contacting the Geophysical Institute at the University of Alaska (907-474-7558) it will be possible to obtain satellite images of the Beaufort Sea within three to four hours. Each frame containing a satellite image will cost approximately $124 and can be picked up at the Gilmore Tracking Station located near Fairbanks, Alaska.

Since the images provided by the Landsat 4 and 5 are black and white, they may not provide a clear distinction between the oil and water. However, they will provide a clear distinction between ice and water. This makes it possible for a time lapse sequence of images to show ice movement in the Beaufort Sea. Since an oil spill will follow a trajectory similar to moving ice, satellite surveillance will allow the On-Scene Coordinator to monitor spill movement during the broken ice season.

A major limitation inherent to satellite imagery is that the satellites cannot penetrate cloud cover or dense fog. Therefore, based on the climatic data provided in Section 1, satellite imagery may not be effective for 25 percent of the time between May and September. Also, technical expertise may be required to interpret the information provided by satellite surveillance during the open water season.

4.1.5.2 Satellite Tracking

Radio-tracking buoys provide an alternate approach for oil spill monitoring by satellite surveillance. This technique was demonstrated during the summer of 1983 when U.S. Coast Guard personnel deployed ten radio-transmitting buoys in the Beaufort Sea. Nine of these buoys remained in service for up to 85 days and transmitted radio signals which were received by the satellite "Service Argos". These signals were re-transmitted to a ground tracking station thereby making it possible to continuously monitor the movement of the buoys. Although this technique will work during periods of heavy cloud cover, it should be recognized that the buoys can be destroyed by ice or washed ashore.

It should be recognized that these buoys may be capable of tracking oiled ice floes and oil in heavy concentrations of broken ice. However, it has not been verified that they will track oil slicks in open water for extended lengths of time.

4.1.6 Summary

Visual detection and aerial surveillance represent the best options for monitoring surface spills in the Beaufort Sea. The reasons for this are three-fold: 1) there are numerous aircraft available on the North Slope of Alaska which can be used for this purpose, 2) it can be rapidly implemented and easily enhanced by radio-tracking buoys and 3) extended daylight will allow this technique on a 24-hour basis during the summer season. It would also be appropriate for the On-Scene Coordinator to consider satellite imagery on clear days for monitoring oil spill movement in ice-infested waters.

4.2 OIL SPILL TRAJECTORY MODELS

4.2.1 ACS Beaufort Sea Trajectory Model

During 1983, Alaska Clean Seas (ACS) developed the ABSORB Oil Spill Trajectory Model for predicting oil spill movement for the Beaufort Sea region shown in Figure 4.2.1.1. The objectives for this model are to: 1) help ACS member companies identify areas along the Beaufort Sea coastline that could be impacted by an oil spill, and 2) serve as a training aid for response planning.

The ABSORB Oil Spill Trajectory Model is maintained in the ACS Anchorage Office and run on an IBM personal computer. The following data is required to operate this model:

- Type of spill [Instantaneous (Bbl) or continuous release (Bbl/day)].
- Material spilled (Crude oil or diesel fuel).
- Spill location (X and Y grid coordinates).
- Ice conditions (Open water or percent broken ice).
- Wind speed and direction for previous 12 hours.

Using this data, the trajectory model will provide the following information:

- Direction of spill movement.
- Spill width.
- Spill thickness.
- Amount of oil evaporated.
- Amount of oil in water column.
- Time of contact with land and location.
- A plot showing the direction of spill movement.

An example of the trajectory model input and output obtained from the Oil Spill Contingency Planning Manual is provided in Tables 4.2.1.1 and 4.2.1.2 and Figure 4.2.1.2.

A careful analysis of the output data, Table 4.2.1.2, reveals that the ACS model has several limitations. For example, the model output stops after the leading edge of a spill contacts shore. As shown in Table 4.2.1.2, the input data shows that a 2,400 barrel per day spill contacts shore in 23 hours. Although the spill is continuous, the model shuts down when contact occurs

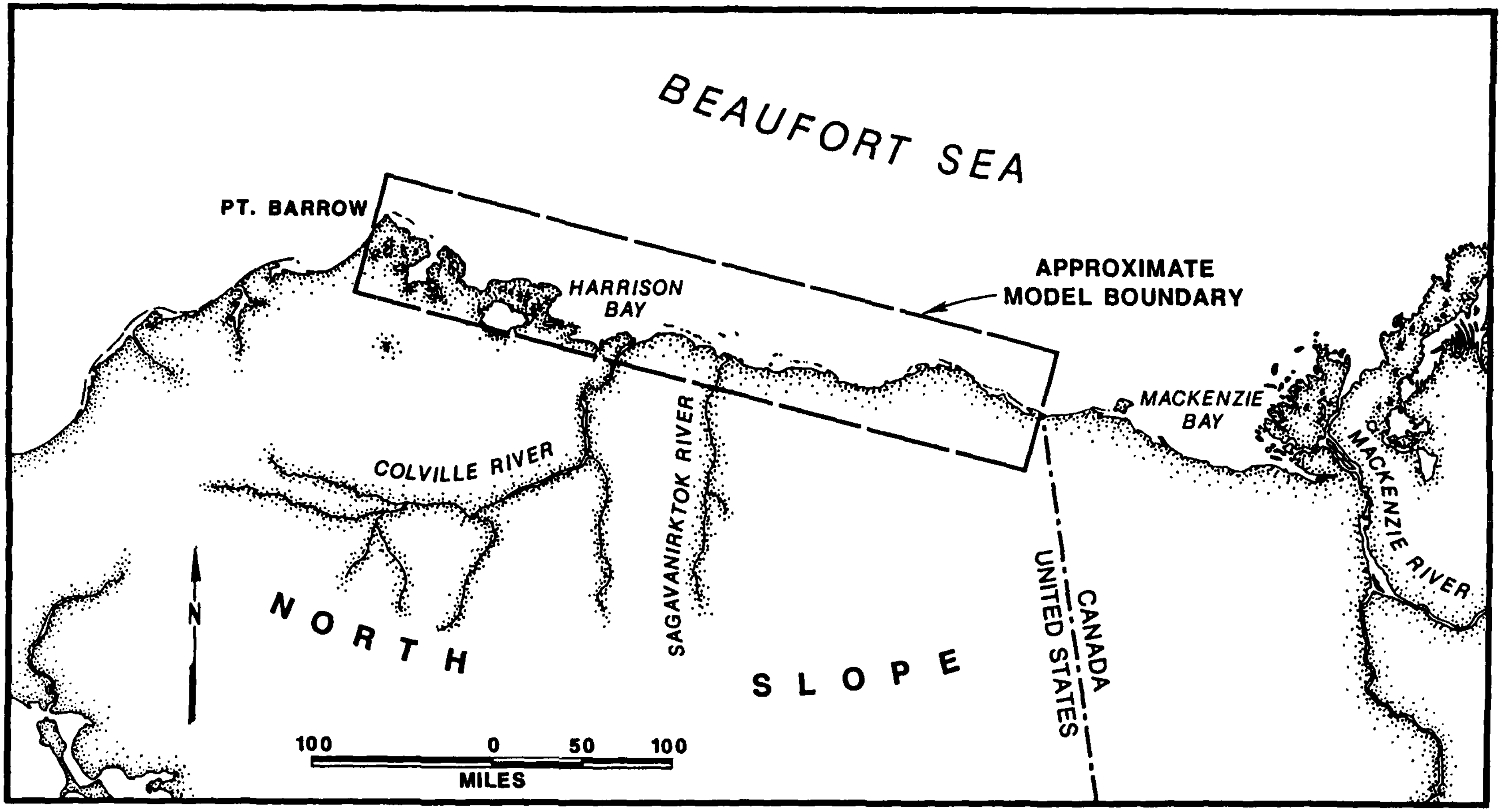


Figure 4.2.1.1

BOUNDARIES FOR THE ABSORB OIL SPILL TRAJECTORY MODEL

Table 4.2.1.1

SCENARIO FOR A
CONTINUOUS SPILL IN ICE-INFESTED WATER
INPUT FOR ABSORB TRAJECTORY MODEL

STEP	PARAMETER	INPUT VALUE	COMMENTS
1	Grid Coordinate - X Grid Coordinate - Y	214.0 10.0	Pt. Thompson Area
2	Substance Spilled	1	Crude Oil
3	Rate of Flow	2400	Bbl/day
4	Average 12-hr Wind Speed Average 12-hr Wind Direction	15 E	Knots
5	Frequency of Wind Update	100	Hours
6	Percent of Ice Cover	20	Percent
7	Frequency of Ice Cover Update	10	Hours
8	Check Color Monitor		___
9	Wind Speed During Hour 1 Wind Direction During Hour 1	10 NE	Knots
10	Change the rate of flow or percent ice cover?	2	No
	Change the rate of flow or percent ice cover?	1	Yes
	Parameter changed?	1	Both Parameters
	New rate of flow during Hour 20	0	Bbls/day
	New percent ice cover during Hour 20	5	Percent
11	Start the Plotter	C	
12	Start a New Case	F2	

Table 4.2.1.2

ABSORB TRAJECTORY MODEL
OUTPUT FOR A CONTINUOUS SPILL
IN ICE-INFESTED WATER

Beaufort Sea Oil Spill Model - 06-08-1983 14:16:29
Spill Location: Grid X = 214 Grid Y = 10
Product Spilled: Crude Oil
Type of Spill: Continuous Spill In Ice Infested Waters
Spill Rate: 2400 Bbl Per Day
Average Wind Speed for Preceding 12 Hours: 15 kts Direction: E

Hourly Spill Status - Continuous Oil Spill

		Winds		Coordinates		Volume of Oil (Barrels)					Spill Size	
Time Hr	Ice Pct	Spd kts	Dir T	Grid X-Cord	Grid Y-Cord	Atmos	Water Surface	Water Column	Sea Floor	Total	Width Ft.	Thick Cm.
1	20	10	NE	213.60	9.83	3	94	3	0	100	32	0.254
2	20	10	NE	213.07	9.68	6	187	7	0	200	32	0.254
3	20	10	NE	212.56	9.33	9	280	10	0	300	32	0.254
4	20	10	NE	212.09	9.38	13	373	14	0	400	32	0.254
5	20	10	NE	211.65	9.23	15	468	17	0	500	32	0.254
6	20	10	NE	211.24	9.08	18	561	20	0	600	32	0.254
7	20	10	NE	210.84	8.93	21	655	24	0	700	32	0.254
8	20	10	NE	210.58	8.73	24	748	28	0	800	32	0.254
9	20	10	NE	210.33	8.53	27	841	32	0	900	32	0.254
10	20	10	NE	210.09	8.33	30	934	36	0	1000	32	0.254
11	20	10	NE	209.87	8.13	33	1027	40	0	1100	32	0.254
12	20	10	NE	209.67	7.90	36	1119	44	0	1200	32	0.254
Spill on Island or Low Coastal Area - Calculations are Continuing												
13	20	10	NE	209.26	7.75	40	1212	48	0	1300	32	0.254
Spill on Island or Low Coastal Area - Calculations are Continuing												
14	20	10	NE	208.86	7.59	43	1303	53	0	1400	32	0.254
15	20	10	NE	208.51	7.44	47	1395	58	0	1500	32	0.254
16	20	10	NE	208.17	7.29	50	1487	63	0	1600	32	0.254
17	20	10	NE	207.83	7.14	54	1579	68	0	1700	32	0.254
18	20	10	NE	207.55	6.99	58	1669	73	1	1800	32	0.254
Spill on Island or Low Coastal Area - Calculations are Continuing												
19	20	10	NE	207.34	6.84	61	1760	78	1	1900	32	0.254
Spill on Island or Low Coastal Area - Calculations are Continuing												
20	5	10	NE	207.05	6.63	63	1755	81	1	1900	32	0.254
Spill on Island or Low Coastal Area - Calculations are Continuing												
21	5	10	NE	206.77	6.42	64	1751	84	1	1900	32	0.254
Spill on Island or Low Coastal Area - Calculations are Continuing												
22	5	10	NE	206.48	6.20	66	1746	87	1	1900	32	0.254
Spill on Island or Low Coastal Area - Calculations are Continuing												
23	5	10	NE	206.19	5.99	67	1742	90	1	1900	32	0.254

Oil Spill has Reached Shore

BEAUFORT SEA OIL SPILL TRAJECTORY MODEL

CONTINUOUS SPILL IN ICE-INFESTED WATER
SPILL AT GRID X = .214 AND Y = 10
RATE OF SPILL IS 0 BBLS/DAY
CURRENT DATE IS 06-08-1983   CURRENT TIME IS 14:38:51

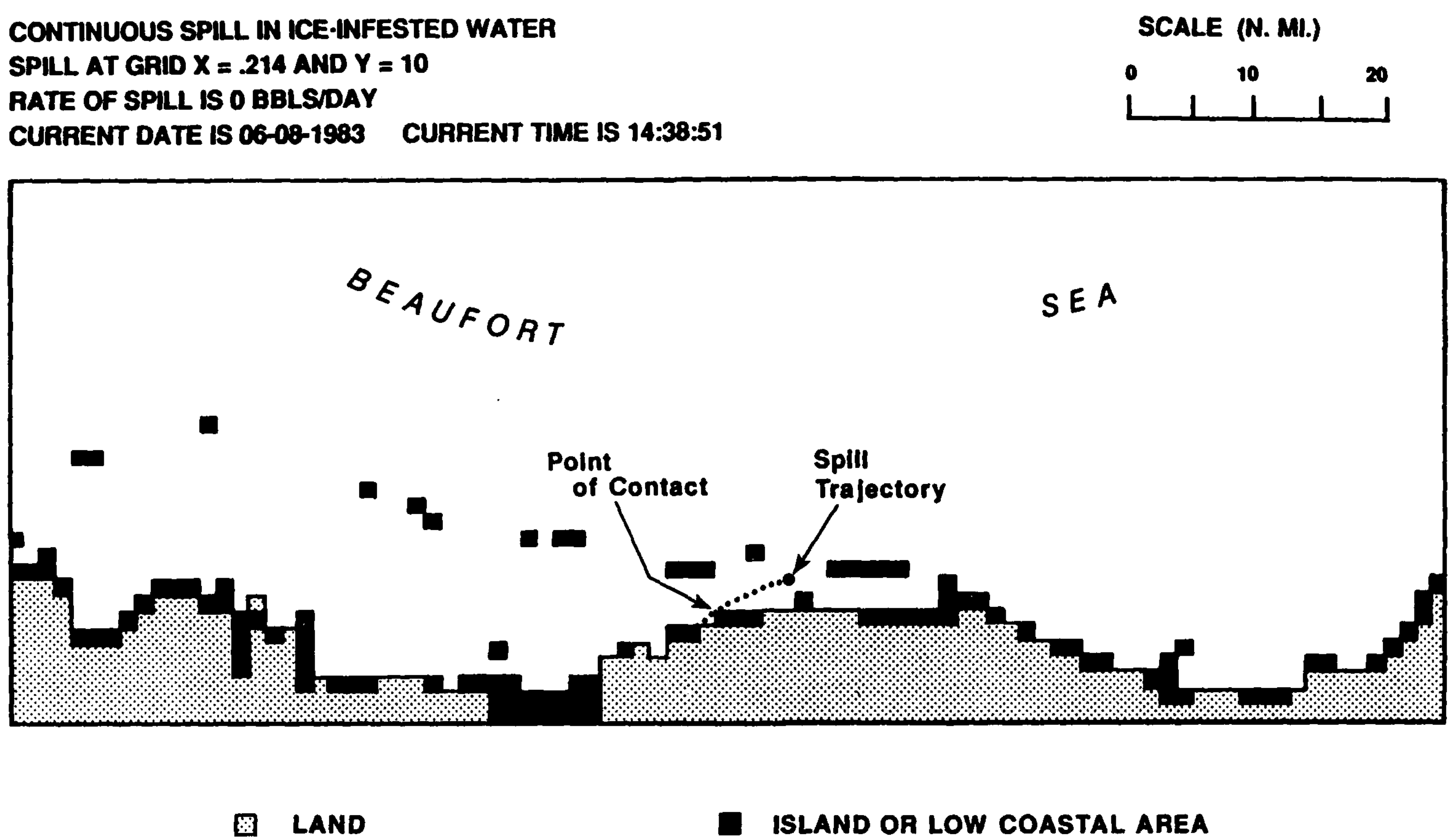


Figure 4.2.1.2

PLOT OF OIL SPILL TRAJECTORY MODEL

and provides no further information on spill behavior or trajectory.

Another limitation is that the model assumes all slicks will maintain a uniform thickness of 0.254 centimeters. Based on the nature of the oil and the environmental conditions, the slick could be much thinner or thicker. The ACS model also forces the spill to maintain a very narrow width. For the 2,400 barrel per day spill under consideration in Table 4.2.1.2, the maximum spill width was 32 feet. In reality, one would expect this quantity of oil to form slicks that were much wider. This would probably be the case in the Beaufort Sea due to winds which frequently change directions.

The primary advantage inherent to the ACS Beaufort Sea trajectory model is that it is easy to use and readily accessible. Although it is not capable of predicting the magnitude of shoreline impact which might result from an oil spill, it will provide a reasonable assessment of how long it will take for the spill to contact shore and the likely point of impact. This information can be used by the On-Scene Coordinator as a preliminary basis for developing a response strategy. Access to the ACS Beaufort Sea trajectory model can be obtained by contacting the ACS Manager at (907) 349-6491. Although this model is readily available, it has not been verified with actual or simulated oil spills.

4.2.2 NOAA Oil Spill Trajectory Model

The National Oceanic and Atmospheric Administration (NOAA) has developed the On-Scene Spill Module (OSSM) to predict the movement and spreading of oil on water. This module has the following operating modes:

- o <u>Climatological Assessment</u> - predicts spill movement based on a Monte Carlo simulation of regional winds and currents obtained from scientific literature.
- o <u>Tactical or Short-Term Assessment</u> - predicts spill movement and spreading based on meteorological and oceanographic conditions at the spill site.
- o <u>Receptor Mode Assessment</u> - provides the following information:

    1. The probability of a spill impacting a specific point or receptor site.
    2. The time required for a spill to reach a given receptor site.
    3. The percent of a spill which will reach a given receptor site.

4. Whether the answers to the previous questions can be significantly altered by implementing appropriate oil spill countermeasures.

One of the main advantages of OSSM is that it can identify the meteorological conditions which will cause an oil spill to impact identified areas. Also, it allows the user to generate a shoreline profile in less than 10 minutes by using a micro-computer.

To obtain access to the OSSM, the On-Scene Coordinator or Scientific Support Coordinator should contact Dr. Jerry Galt or Ms. Deborah Payton at the NOAA office in Seattle, Washington (206-526-6317). To initiate the OSSM, the On-Scene Coordinator or Scientific Support Coordinator, must provide: 1) the spill location, 2) the type of material spilled, 3) the quantity of the spill, and 4) the time that the spill occurred.

In approximately 1½ to 2½ hours after obtaining this information, the OSSM operators will provide a map showing the spill's trajectory and likely points of contact with land based on forecasted meteorological conditions. It should be recognized that several hours will be required to transport the maps from Seattle, Washington to the Spill Command Post in Alaska. However, pertinent information regarding spill movement and probable points of contact with land can be transmitted to the Command Post by telephone.

A major limitation inherent to OSSM is that it can not perform trajectory analysis for oil spills in ice-infested water. As a result, its applicability for the Beaufort Sea may be limited to late July through early September. In temperate water, the reliability of this model has been verified using actual spill data.

4.3 OIL SPILL CONTAINMENT

4.3.1 Booms

Booms are mechanical barriers which extend above and below the water surface. They are used to: 1) divert oil spills to areas where cleanup can be performed, 2) contain and concentrate spilled oil, and 3) protect environmentally sensitive areas threatened by oil spills.

Although the size, shape, and materials of construction vary, booms generally have four basic components. As shown in Figure 4.3.1.1 most booms include 1) a means of flotation, such as a air-filled compartment or solid float, 2) a freeboard section which extends above the water surface and prevents oil from flowing over the top of the boom, 3) a skirt which extends below the surface to keep oil from escaping beneath the boom, and 4) a tension member which gives the boom the strength to withstand forces exerted by currents, waves, and winds. Ballast is usually attached along the lower edge of the boom's skirt so that it will hang vertically in the water. Otherwise, the skirt would be deflected by currents and allow oil to escape beneath it.

Booms are generally grouped into four categories: offshore, harbor, calm water, and fire containment. These categories along with the types of boom available in Alaska are discussed in Sections 4.3.4 to 4.3.6.

4.3.2 Boom Behavior

Most booms cannot provide effective oil spill containment in currents above 1 knot. As shown in Figure 4.3.2.1, currents above 1 knot will cause oil to escape under the boom's skirt. Although 1 knot is generally identified as the velocity where this will occur, the actual velocity depends on the skirt depth, oil viscosity, oil specific gravity, and oil thickness contained by the boom.

In areas where the water current exceeds 1 knot, booms can sometimes be used to divert oil to areas where the current is lower and containment can be achieved. Figure 4.3.2.2 shows boom angle of deployment that can be used to contain oil along shorelines for currents greater than 1 knot.

Wind is another factor which affects boom performance. Unless the boom is securely anchored from both sides, strong gusting winds opposing the water current may cause it to move back and forth. This can cause oil to splash over the boom. Also, as shown in Figure 4.3.2.1, if the wind and current are moving in the same direction, splash-over can occur.

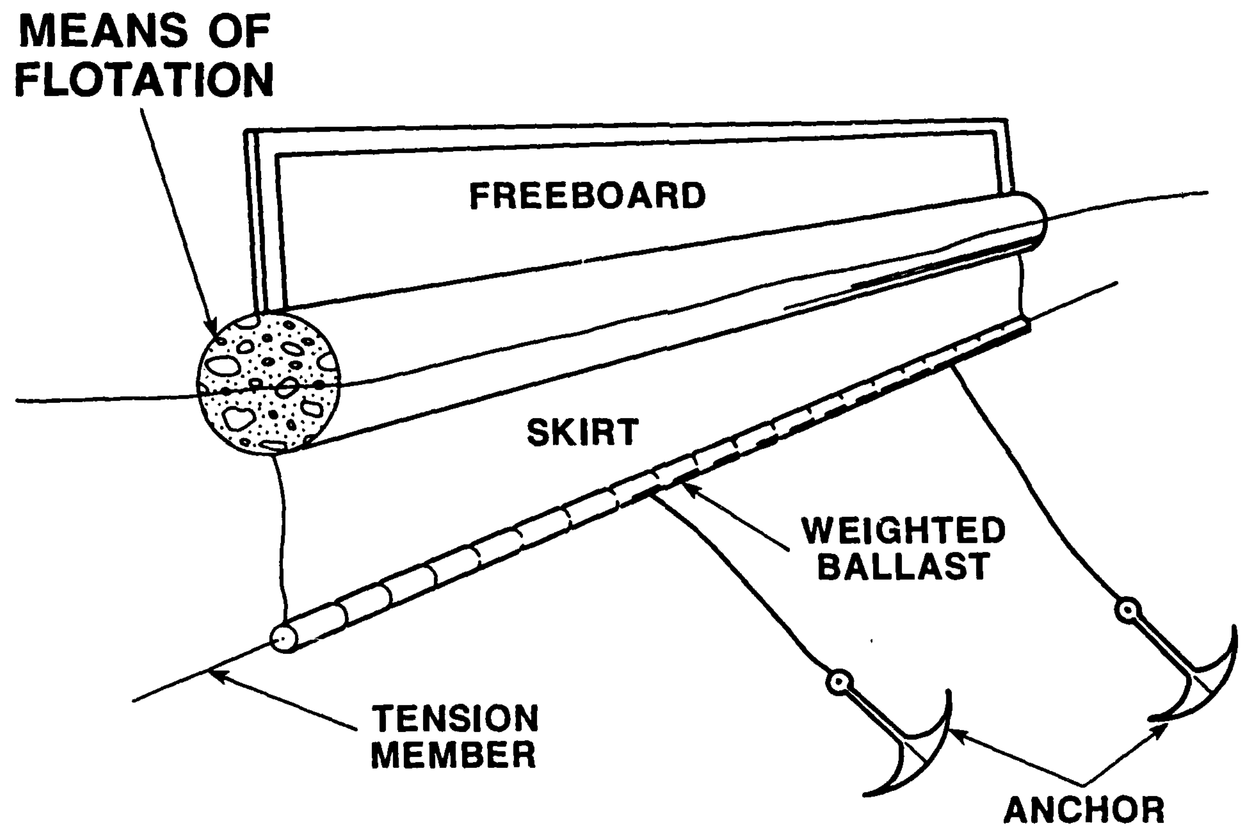
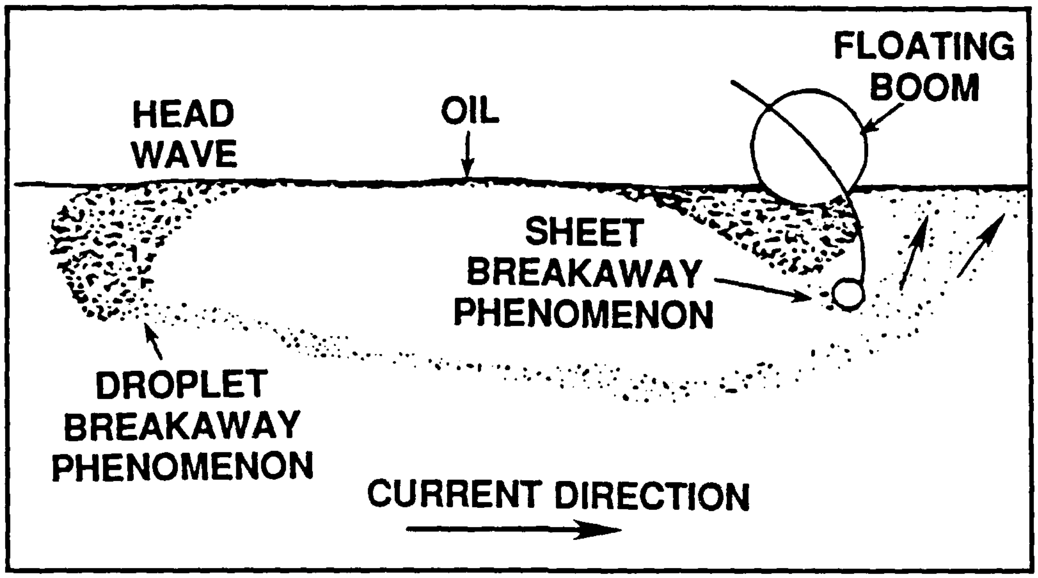
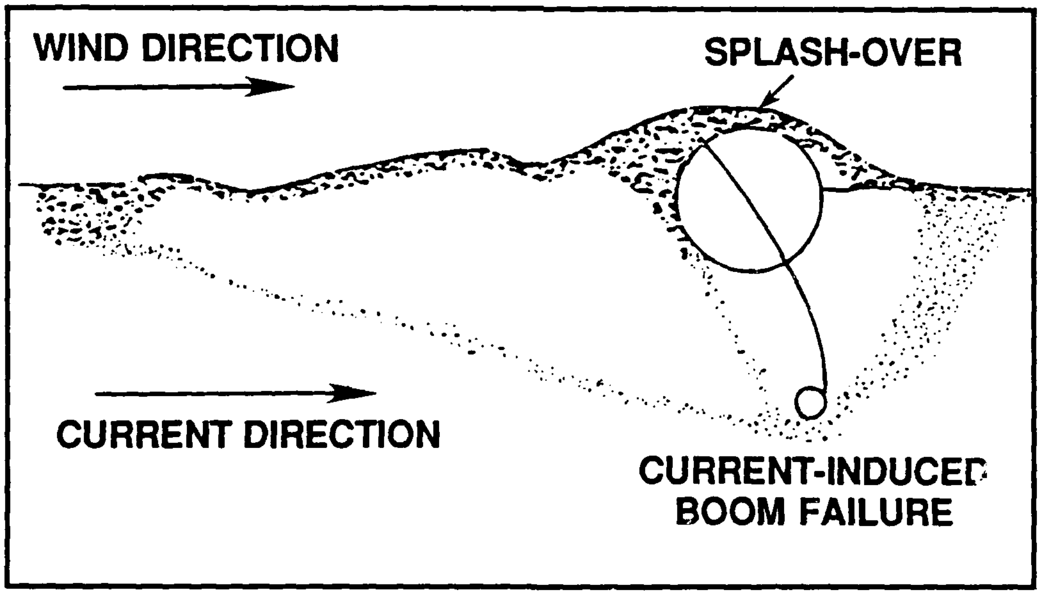


Figure 4.3.1.1 CONVENTIONAL BOOM COMPONENTS

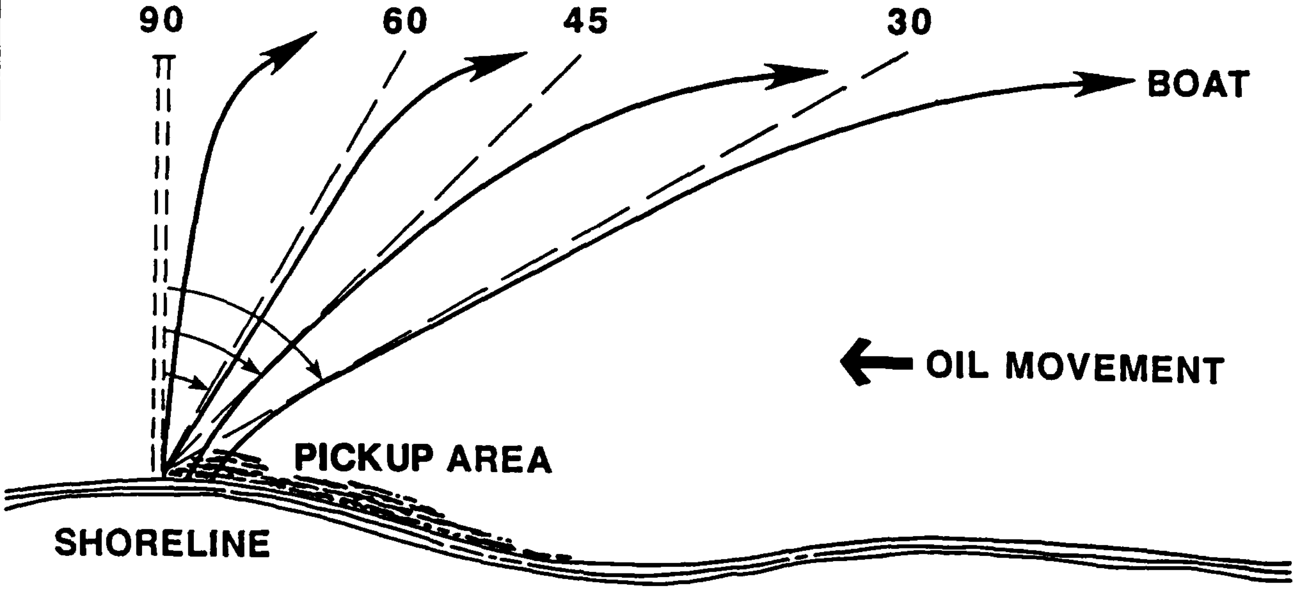


Oil Escaping Due to Excessive Current



Oil Escaping Due to Wind and Current

Figure 4.3.2.1	FACTORS AFFECTING BOOM PERFORMANCE



Current vs. Boom Deployment Angle

Current (kts.)	Current (fps.)	Maximum Boom Angle(°)
1.1	2.2	50
1.4	2.4	45
1.6	2.7	40
1.7	2.9	35
2.0	3.4	30

Note: Difficulty in deployment will increase and effectiveness will decrease as a function of water velocity.

Figure 4.3.2.2	ANGLE OF BOOM DEPLOYMENT

4.3.3 Boom Deployment

As shown in Figures 4.3.3.1 and 4.3.3.2 booms can be deployed in a number of configurations to capture and contain offshore oil spills. Additionally, booms can be used to divert oil that is approaching an area which is environmentally sensitive as in Figure 4.3.3.3.

In addition to containment and diversion, booms can also be used to prevent or exclude oil from entering areas such as tidal zones, estuaries, marshes, or beach areas that are environmentally sensitive. To effectively implement exclusionary booming (Figure 4.3.3.3), several booms parallel to each other may be required. By definition, exclusionary booming is the process of using boom to prevent oil from entering a given area.

4.3.4 Offshore Booms

Offshore booms are generally used to contain oil in the open sea and are designed to withstand 9-12 ft. waves. Because the Beaufort Sea is relatively mild, no booms with this capability are stockpiled in Alaska.

4.3.5 Harbor Booms

Harbor booms are used at offshore drilling sites, terminals, and other near-shore facilities. Sufficient harbor boom is available in Alaska to provide containment during a major spill in the Beaufort Sea. In the event that additional boom is required it can be readily obtained from oil spill co-ops in California. The following sections describe harbor booms currently available in Alaska.

4.3.5.1 Goodyear Sea Sentry Boom

The Goodyear Sea Sentry Boom is one of the largest and most rugged booms stockpiled in Alaska. It is constructed from a heavy rubberized fabric with Kevlar tension members and 3/4" chain ballast. The flotation chambers on this boom must be inflated with air prior to deployment. Due to its weight and bulkiness (4,800 lb/pallet), a crane or forklift is required to lift this boom. At the spill site it can be deployed by personnel using work boats to pull it into position.

Tests performed by the USCG in 1977 demonstrated that the Goodyear Sea Sentry Boom does not perform well in offshore areas that have waves greater than three feet. It has been used by the USCG on the East Coast in light ice conditions typical of those found during freezeup in the Beaufort Sea. Due to its "heavy-duty" construction, it can be used for oil spill containment under calm weather conditions in water containing broken ice. It should be recognized that sharp ice edges can puncture the flotation chambers on this boom.

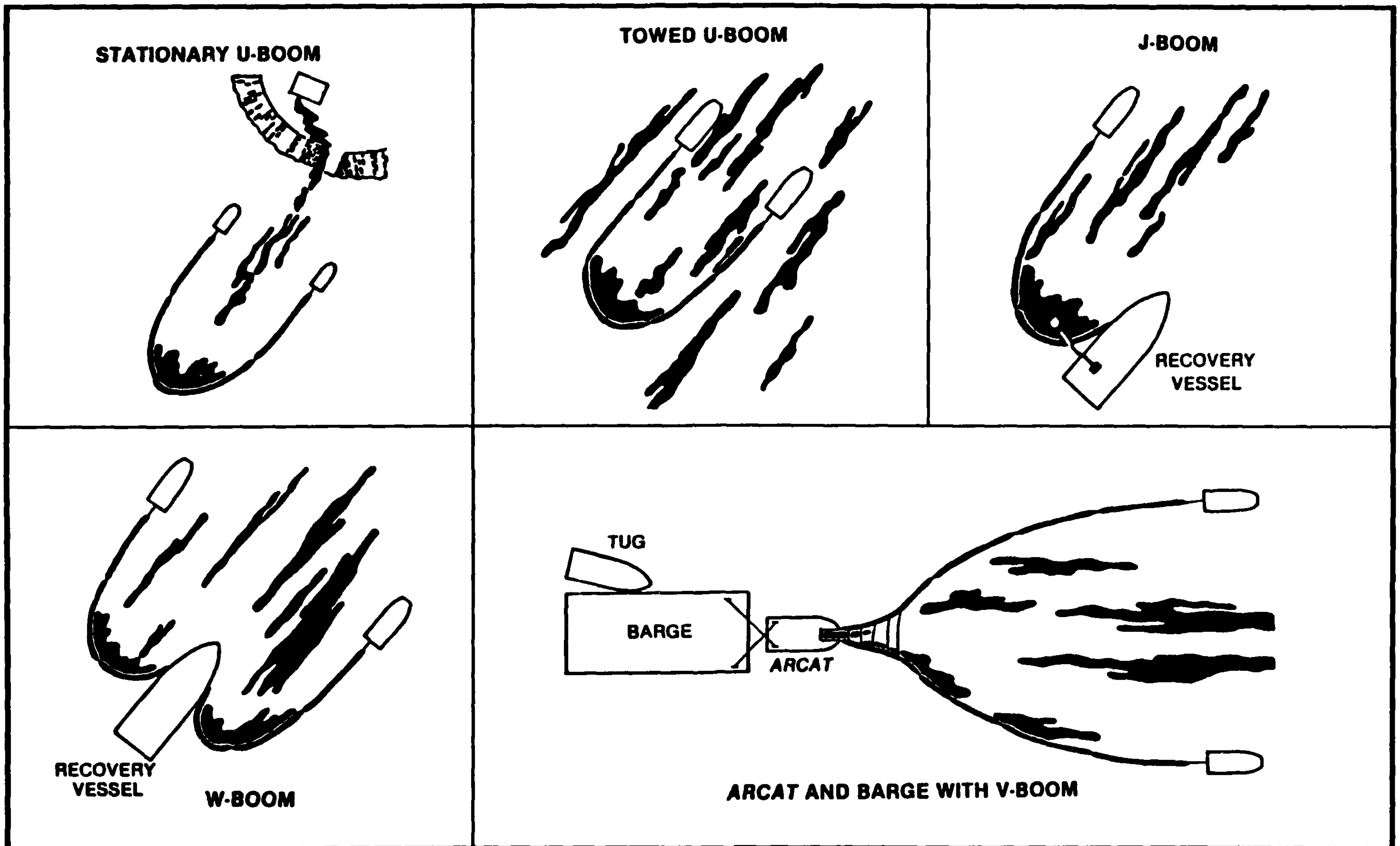


Figure 4.3.3.1

CONTAINMENT USING TOWED BOOM CONFIGURATIONS

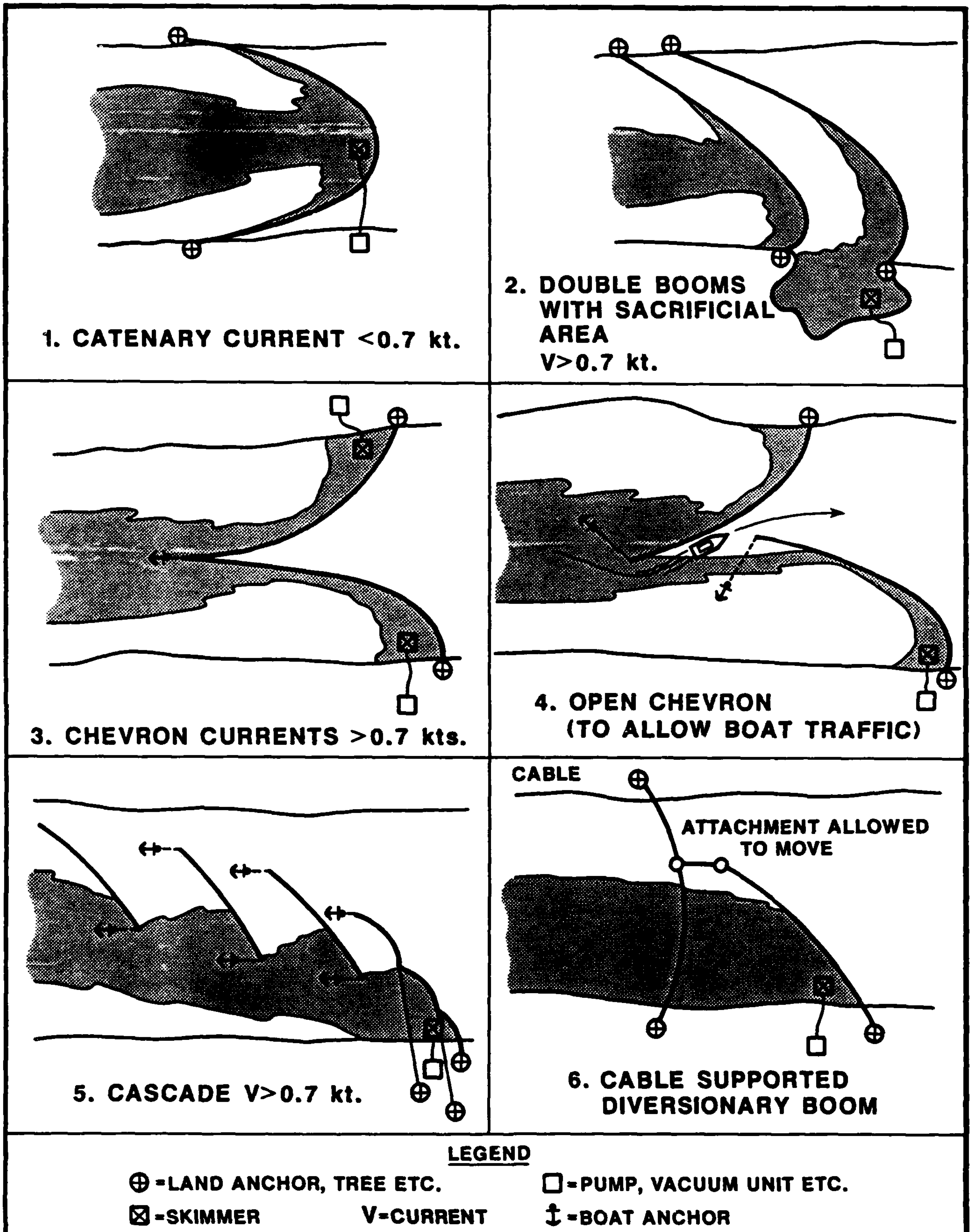


Figure 4.3.3.2 INSHORE BOOM CONFIGURATIONS

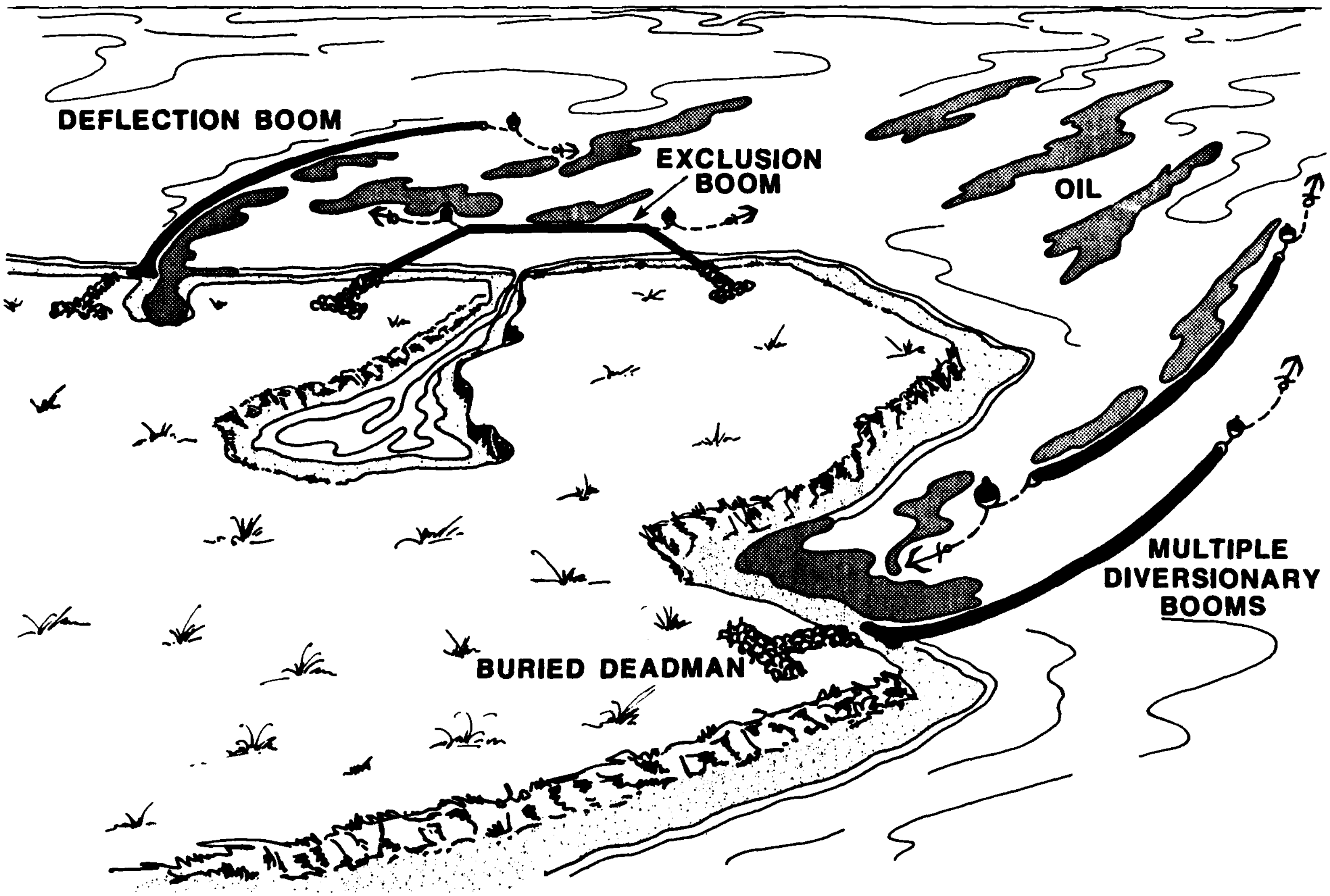


Figure 4.3.3.3

DEFLECTION AND EXCLUSION BOOMING

Quantity in Alaska	Freeboard	Draft	Weight	Minimum Tensile Strength
2,000 ft.	24 in.	36 in.	14.6 lb./ft.	36,000 lbs.

4.3.5.2 Kepner ReelPak Boom

The Kepner ReelPak Boom (250 ft. per reel) is ideally suited for rapid deployment in open water. This boom contains a number of one-way valves and a steel ring which cause it to self inflate when pulled from its storage reel. Although this boom performs well in open water with waves less than 3 ft., it is not suitable for oil spill containment in water with moving broken ice.

Quantity in Alaska	Freeboard	Draft	Weight	Minimum Tensile Strength
11,800 ft.	8 in.	12 in.	1.7 lbs./ft.	18,000 lbs.

4.3.5.3 Pedico - Ocean Dike Boom

The Pedico - Ocean Dike boom is similar to the Kepner Reelpak boom. It comes in 75 ft. sections which are stored in trailers containing 900 ft. of boom. This boom performs well in ice free water with waves less than 3 ft. However, it is not suitable for waters containing moving broken ice.

Quantity in Alaska	Freeboard	Draft	Weight	Minimum Tensile Strength
5,400 ft.	10 in.	12 in.	2 lb./ft.	16,500 lbs.

4.3.6 Calm Water Booms

Calm water booms are small, lightweight, and designed for oil spill containment in shallow near-shore water. The following calm water boom is stockpiled in Alaska.

4.3.6.1 American Marine - Simplex Boom

This American Marine-Simplex boom has solid foam for flotation. Consequently, it will remain afloat if punctured. Although damage may occur, this boom is suitable for deployment in water with broken ice.

Quantity in Alaska	Freeboard	Draft	Weight	Minimum Tensile Strength
3,000 ft.	6 in.	12 in.	1.7 lb./ft.	18,640 lbs.

4.3.6.2 Pedico - EPI Mini Boom

The Pedico-EPI Mini boom has solid foam for flotation. It is suited only for calm, open water conditions and shoreline protection.

Quantity in Alaska	Freeboard	Draft	Weight	Minimum Tensile Strength
3,000 ft.	4 in.	6 in.	1/2 lb./ft.	N/A

4.3.7 U.S. Coast Guard Boom

This boom consists of floats and a vertical skirt. It is constructed from rubberized fabric. Each 50 ft. (15 meter) section is divided into 10 ft. (3 meter) segments with inflation chambers on either side as shown in Figure 4.3.7.

Two tension chains are located at the mid-point of this boom, while a third chain is at the bottom of the skirt. Connections are made using a fiberglass rod and shackles attached to the chains. Each 3 meter segment has two handles and each 15 meter section has two lifting loops. Two to four persons are required to inflate and deploy this boom.

During field tests near St. Johns, Newfoundland, a barrel of oil spilled on the upwind side of this boom escaped in about 10 minutes. Oil losses were due to splash-over and underflow. During this test, winds were 10 to 15 knots and the sea state was about 2 to 3. The boom was left attached to a mooring buoy for 27 days. Three severe storms subjected this boom to steep breaking waves 5 to 7 meters in height. As a result, five shackles were disconnected on the tension lines and seams were torn at the end of the chain pockets. No further damage was found.

The U.S. Coast Guard Boom is rugged and well constructed. It has good wave riding conformance except in short, breaking waves. Approximately 9,000 ft. of this boom is located at Coast Guard facilities in Alaska. Similar to the Goodyear Sea Sentry Boom, this boom has air flotation chambers which could be punctured by moving ice.

4.3.8 Fire Containment Boom

Field tests performed in Alaska and Canada demonstrated that in-situ burning (see Section 4.7.2) can be an effective oil spill countermeasure if the oil is at least 3 millimeters thick. Under calm water conditions, the following fire containment booms can be used to ensure that this thickness is maintained for in-situ burning:

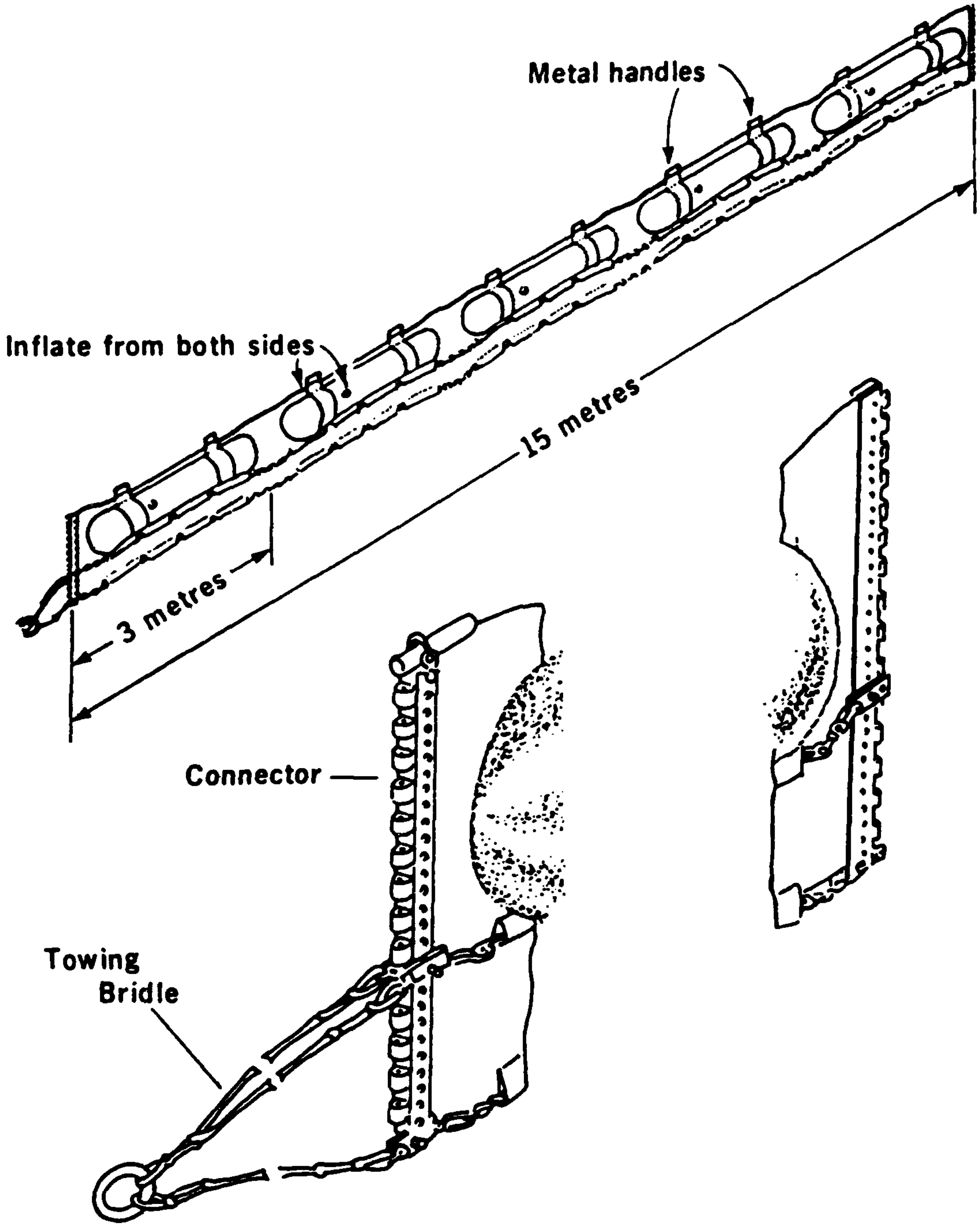


Figure 4.3.7	U.S. COAST GUARD BOOM

- Globe International Pyroboom. This boom consists of refractory and metallic materials coated with a high temperature polymer (Figure 4.3.8.1). Buoyancy is provided by a series of stainless steel floats. This boom is capable of containing burning oils at temperatures up to 2,400°F for 6 hours. Preliminary tests performed by Alaska Clean Seas suggest that the boom can contain burning crude oil (1,750°F) for 24 hours or more.

  The Pyroboom is designed for repeated use. All parts are easily removable and can be replaced if damaged during operation. Also, the connectors for this boom are fire proof above the water line. This boom is manufactured and distributed by Globe International Inc., P.O. Box 1062, Buffalo, New York 14240 (800-325-1585).

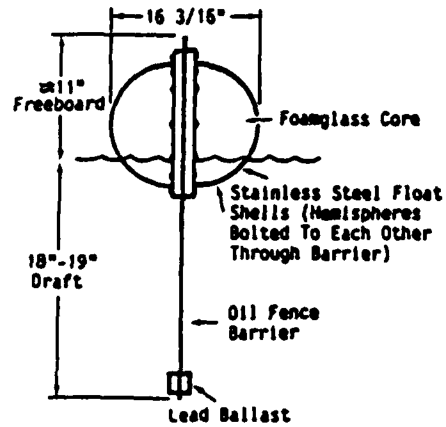
- Kepner Fire Gard Boom. This boom consists of a stainless steel coil wrapped around a 2½" x 8" foam pad. The steel coil is covered with two layers of Thermotex Refractory fabric and coated with an abrasion-resistant polymer (Figure 4.3.8.2). This boom has a compaction ratio of approximately 4:1. As a result, it can be mounted on a reel for rapid deployment.

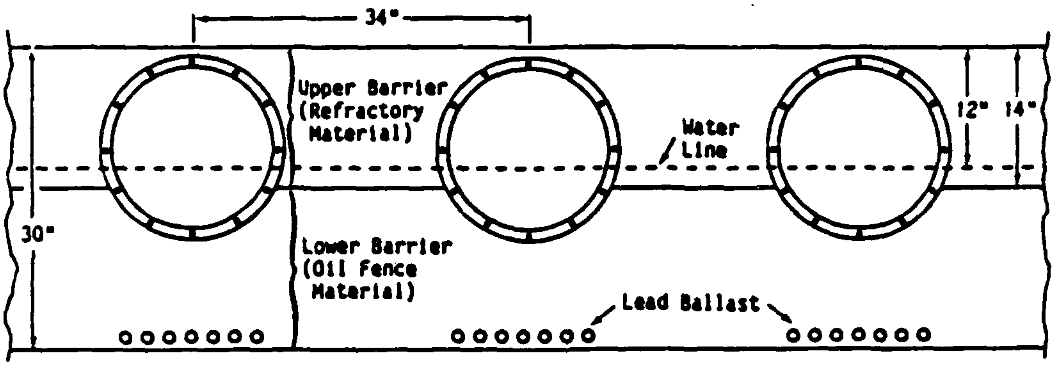
  When the Kepner Fire Gard Boom is deployed, the stainless steel coil expands causing the boom to inflate with air. If the air chamber is punctured, this boom will continue to float due to the internal foam pad.

  During a test at Texas A&M University, the Fire Gard Boom withstood temperatures up to 2,000°F for more than 8 hours without significant damage. After this test, the boom was still capable of being wound on a reel and redeployed. Tests performed by Alaska Clean Seas demonstrated that it can contain burning crude oil for 24 hours without experiencing significant damage. This boom is manufactured and distributed by Kepner Plastics Fabricators, 3131 Lomita Blvd., Torrance, CA 90505 (213-325-3162).

- Shell Fire Containment Boom. This boom consists of 5-gallon steel cans wrapped in multiple layers of thermoglass (Figure 4.3.8.3). To provide abrasion protection, this boom is encased in a chain-link fence. Tests performed by Alaska Clean Seas demonstrated that the Shell boom can contain burning oil for 24 hours. As of August 1986, no public statements have been made regarding whether this boom is commercially available. However, approximately 2,500 feet is stockpiled in the ACS warehouse at Prudhoe Bay.

- 3M Fire Boom Blanket. As shown in Figure 4.3.8.4, this blanket consists of several insulating materials which are designed to convert any conventional boom into a fire





Abrasion Protection: Stainless-steel shells for flotation. Upper refractory material (above water) impregnated with RTD silicon rubber.

Fire Protection: Heat-resistant, closed-cell foam glass surrounded by stainless steel for floats. Fiberfrax fabric (with inconel wire and silicon rubber treatment) in upper half of boom.

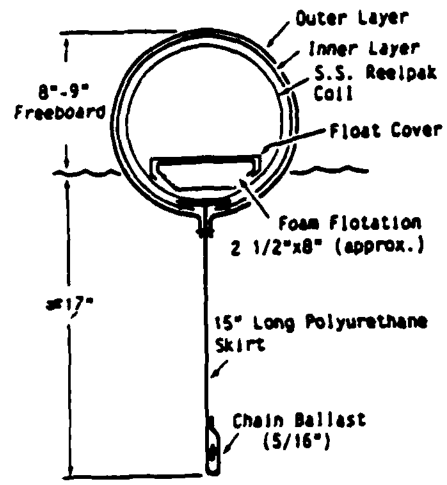
Flotation: Hemispheres (16-in. diam.) at 34-in. spacings bolted together through boom fabric. Shells and buoyant cores easily removed and reused.

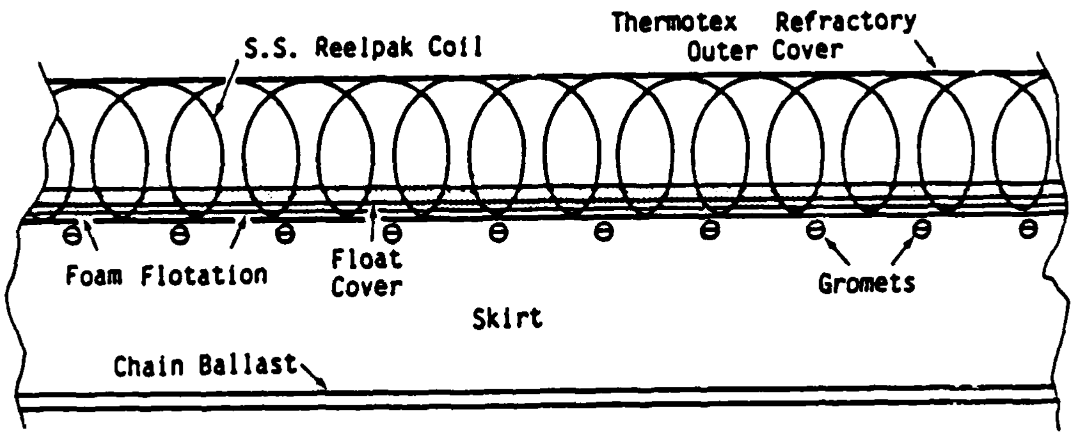
Skirt: Urethane-coated conveyor-belt material.

Tension/Ballast: Fence-boom configuration provides distribution of tension throughout upper wire-reinforced refractory material and lower conveyor-belt material. Ballast provided by lead discs averaging about 2 lb/ft.

Ref: Test and Evaluation of Fire Containment Boom - Alaska Clean Seas

Figure 4.3.8.1	GLOBE INTERNATIONAL PYROBOOM





Abrasion Protection: Outer and inner covers treated with an abrasion-resistent polymer coating.

Fire Protection: Two layers of Thermotex refractory fabric suspended over stainless steel coil. Flotation wrapped with fiberglass fabric.

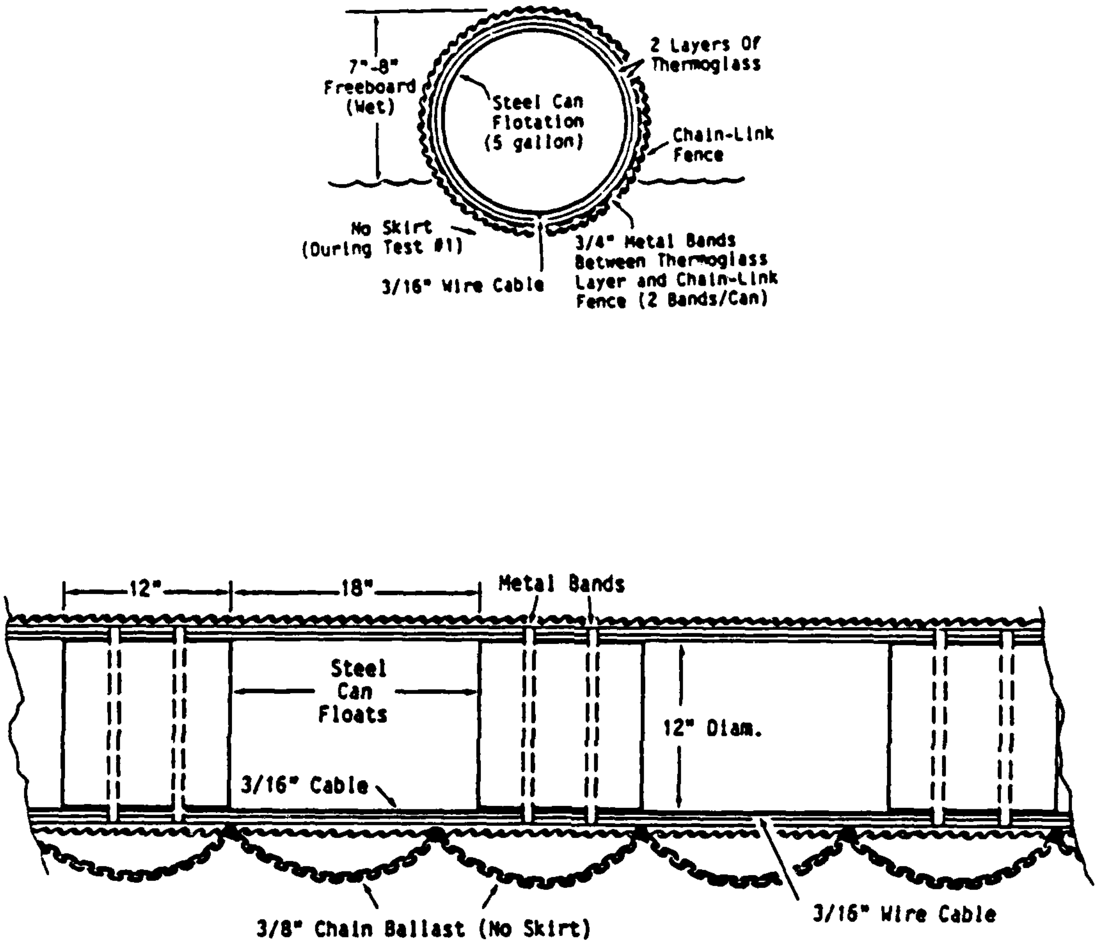
Flotation: 2½-in. x 8-in. multiple-layer, closed-cell Resistex foam flotation running entire length of test boom. Flotation wrapped with fiberglass fabric.

Skirt: 15-in. skirt made of 22-oz. PVC fabric.

Tension/Ballast: Bottom-tensioned and ballasted with 5/16-in. chain. No connector plates used.

Ref: Test and Evaluation of Fire Containment Boom - Alaska Clean Seas

Figure 4.3.8.2	KEPNER FIRE GARD BOOM



Abrasion Protection: (Size/Type) Chain-link fence placed completely around upper, flotation portion of boom.

Fire Protection: Two layers of 70 oz. Thermoglass held adjacent to flotation cans with steel bands.

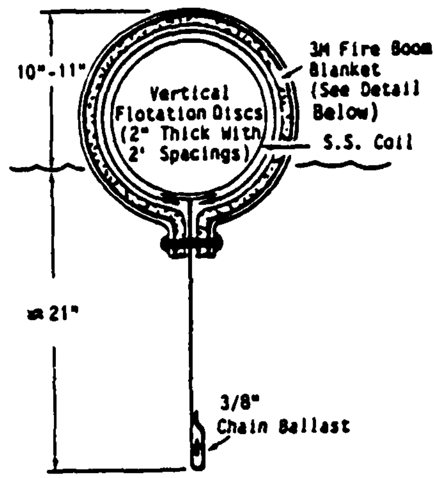
Flotation: 5-gal metal cans, 18 in. apart and attached to 3/16-in. cable.

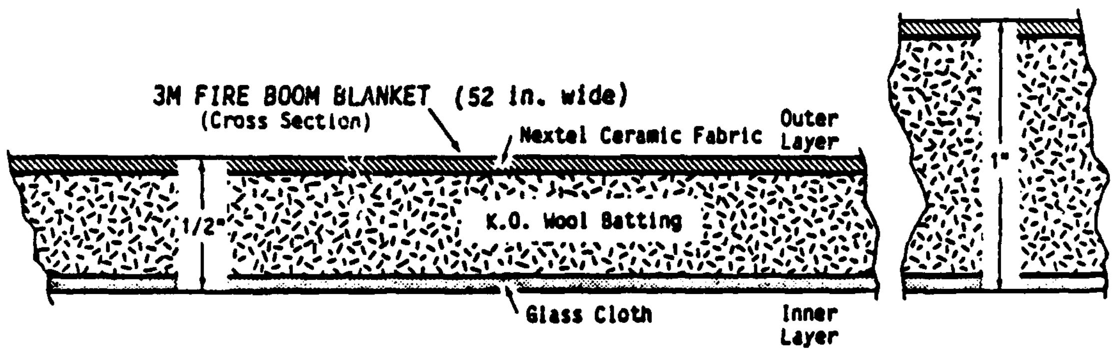
Skirt: None used in this test.

Tension/Ballast: 3/16-in. cable for tension. Cable plus 3/8-in. chain connected to wire fence for ballast.

Ref: Test and Evaluation of Fire Containment Boom - Alaska Clean Seas

Figure 4.3.8.3	SWEPI FIRE CONTAINMENT BOOM WITH CHAIN-LINK OUTER COVER AND NO SKIRT





Outer Layer: #312 Nextel, open-mesh ceramic continuous-filament fabric by 3M, St. Paul, Minnesota. Fabric neoprene-coated.

Middle Layer: K.O. Wool, ceramic batting (short staple fibers) by Babcock & Wilcox, Augusta, Georgia. Half of boom had 1/2-in. batting, and half had 1-in. batting.

Inner Layer: Glass Cloth, Style 1583, fiberglass fabric by Schwabbel, White Plains, N.Y.

Connectors: Pop-rivets placed through blanket and skirt material every 12 inches.

Support Boom: Kepner Compactible Boom with 14-in. flotation, 18-in. skirt, and PVC-fabric-covered coils. Flotation provided by air inside covered coils, plus 2-in. thick polyurethane foam discs spaced 2 ft apart. Ballast, 3/8-in. chain. No connector plates used.

Ref: Test and Evaluation of Fire Containment Boom - Alaska Clean Seas

Figure 4.3.8.4	3M FIRE BOOM BLANKET OVER KEPNER 14"X 18" COMPACTIBLE BOOM

containment barrier. The principal materials of construction for this blanket are 3M's Nextel Ceramic fiber, K.O. Wool Batting and glass cloth. During tests in Alaska, a conventional boom surrounded by the 3M Fire Boom Blanket was able to contain burning crude oil for 24 hours. The boom encased in the fire blanket did not experience any damage during this test.

Offshore tests were conducted in Puget Sound, Alaska during 1985 to evaluate a boom's wave conformance while wrapped in the fire boom blanket. These tests revealed that the blanket did not affect the performance of the boom to which it was attached. The 3M Fire Boom Blanket is marketed by Crowley Environmental Services, 3400 E. Marginal Way South, Seattle, WA 98134 (206-443-8100).

A technical summary of each boom is provided in Table 4.3.8.

Although numerous tests have been conducted onshore, no work has been performed to substantiate how well any of these fire containment booms will contain burning oil in an offshore environment. Since the freeboard for most of the booms is 10" or less, it is unlikely that they would be able to provide effective containment in a 6 to 12 inch harbor chop. Similar to most conventional booms, it is unlikely that fire containment booms would be able to contain oil in currents greater than 1 knot, seas greater than 3 feet, or winds greater than 20 knots. Also, it is unlikely that they will be effective in water with moving, broken ice.

To date, all of the endurance tests for fire containment booms have been conducted onshore using fresh water which was free of suspended and dissolved solids. This poses a rather interesting question with respect to how well the Shell boom would perform in the Beaufort Sea. Unlike the other fire containment booms which owe their thermal protection to insulating materials, the Shell boom relies on water evaporation for its thermal protection.

When the Shell boom is exposed to burning oil, the water absorbed by its thermoglass evaporates and provides a cooling effect which protects the boom from the heat of combustion. As evaporation occurs, a wicking action draws additional water into the thermoglass. If the water contains suspended or dissolved solids, this material will be deposited on the boom. It is suspected that this would plug the pour space in the thermoglass and stop the wicking action. As a result, the boom would loose its thermal protection.

For example, an earlier version of the Shell boom was tested in a mud reserve pit at Prudhoe Bay during June 1983. After being exposed to burning oil for approximately 30 minutes, it began to sink. An examination revealed that the thermoglass was coated with sediment from the water. This probably stopped the wicking action and caused the boom to fail.

Table 4.3.8

COMPARISON OF FIRE CONTAINMENT BOOM

Boom	Draft in.	Freeboard in.	Weight lb/ft. (dry)	Ballast	Flotation	Fabric	Test Temp. °F	Ability to Contain Oil Offshore
Globe International PYROBOOM	20	10	7.5	Lead	Stainless Steel Hemispheres Containing High Temperatures Foam Materials	Silicone Rubber Interwoven with Metallic Wires and Refractory Materials	2,400°F	Unknown
Kepner Fire Gard	17	9	3.3	5/16" Chain	Air Flotation Provided by Stainless Steel Coil and 2½ in. by 8 in. Internal Foam	Two Layers of Thermotex Refractory Fabric with an Abrasion-Resistent Polymer Coating	2,000°F	Fair to Good in Waters with 1 ft. Harbor Chop.[1]
Shell Fire Containment Boom	21	9	11	9/32" Chain	Air Flotation Provided by 5-Gallon Steel Cans	Multiple Layers of Thermoglass with Plastic Cover Encased in Chain Link Fence	1,650°F	Unknown
3M Fire Boom Blanket	N/A	N/A	2.8	N/A	Any Conventional Boom Capable of Supporting Blanket	Nextel Ceramic Fabric - Outer Layer K.O. Wool Ceramic Batting - Middle Layer Glass Cloth Inner Layer	1,650°F	Fair to Good in Waters with 1 ft. Harbor Chop.[1]

Note: 1. Based on demonstrated performance for similar Kepner Boom.

4.3.9 Sorbent Booms

Sorbent booms are constructed from synthetic material, such as polyurathane or polypropylene, which recovers oil by adsorption and absorption. Adsorption occurs when oil adheres to the material's surface by molecular forces. Absorption occurs when oil is trapped in the pore space between the material's fibers. These processes give sorbents the ability to recover from 10 to 26 times their weight in oil without collecting much water. Sorbents are made in a number of sizes and shapes, including booms, pillows, sheets, and particles.

During August 1977, the EPA tested the 3M Type 270 Sorbent Boom, Conwed Heavy Duty Sorbent Boom, and the Coastal Services Sorbent Boom at its OHMSETT facility in Edison, New Jersey. The maximum observed no-oil-loss tow speed for these booms was 0.6 knots in calm water and 0.5 knots in a 0.3 meter harbor chop. These figures, with respect to no-oil-loss, are lower than the 0.9 knots reported for conventional containment booms in calm water. The primary reason for this, is that the sorbent booms have less freeboard and draft in comparison to conventional booms.

The light weight of sorbent boom provides for easy handling. Two persons can rapidly deploy 200 feet of this boom without problems. The manufacturers recommend connecting sections of this boom by tying the ends together with rope. Based on the August 1977 tests, EPA recommends overlapping the ends of adjoining sections to reduce oil loss between them.

An attempt was made to regenerate oiled sorbent boom by pulling it between two squeeze rollers. In all cases, the boom was extremely hard to pull through the rollers because the sorbent would batch up at the end and tear as it was being pulled through. The fluid recovered during the regeneration process weighed 8.5 to 13 times as much as the dry boom and contained 16% to 50% oil. The oil for this test was a medium viscosity, naphthenic oil. Different oils will yield different results.

4.3.10 Catamaran Mounted Water Spray Jet Boom

In 1979, water spray jet booms, designed by EPA OHMSETT, were mounted on the OHMSETT Catamaran to test their design and performance. The water jet booms concentrated the slicks and increased oil encounter rates for the Catamaran in calm waters and wave conditions at tow speed from 0 to 6 knots. During July 1986, water spray jet booms were installed on an oil recovery vessel owned by Alaska Clean Seas.

4.3.11 Surface Snow/Ice Barriers

During the winter season (generally November to late April), ice and snow can be used to contain oil spills. In offshore locations where ice thickness permits (3 ft. or greater), these barriers can be rapidly constructed with graders and forklifts. As a precautionary measure, it is advisable to spray these barriers with water to form an impermeable barrier which will prevent oil seepage.

4.4 OIL SPILL RECOVERY

Oil spill recovery techniques suitable for the Beaufort Sea are discussed in this section. The objective is to provide the On-Scene Coordinator with a rational basis to prioritize cleanup techniques for various conditions which could exist in the Beaufort Sea. It should be recognized that all recovery techniques have advantages and limitations which govern their performance. Therefore, in addition to being familiar with this information, the OSC is encouraged to obtain input from Cleanup Contractors who have responded to oil spills in the Beaufort Sea.

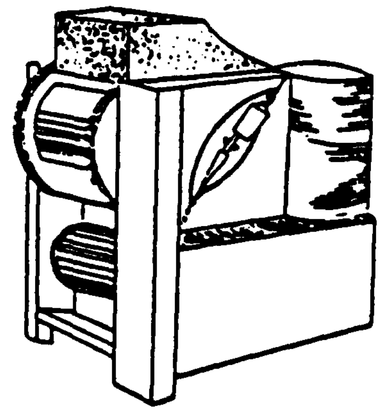
4.4.1 Offshore/Near-shore Cleanup

4.4.1.1 Rope Mop Skimmers

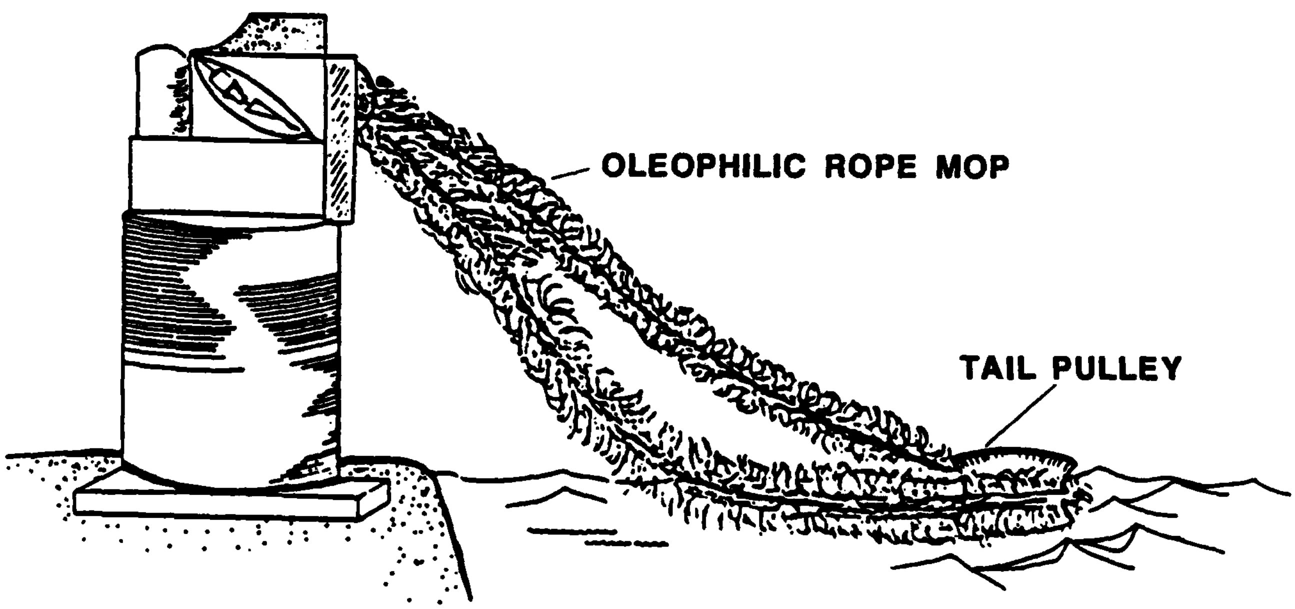
Rope mop skimmers are excellent devices for recovering oil spills in open water and broken ice. These skimmers contain a moving oleophilic rope (polypropylene material with extended strands) that collects free-floating oil on a water surface. Oil is removed from the rope mop by a wringer which is located on land, ice, or vessel. For most rope mop skimmers, the wringer is located directly above a sump that collects the oil as it is squeezed from the rope mop. From there, the recovered oil is usually transferred to a temporary storage container. As shown in Figure 4.4.1.1.1, the rope mop passes through one or more floating tail pulleys to allow maximum contact time with the oil.

Under ideal conditions (open water, calm seas, and no ice) rope mop skimmers have a high oil recovery efficiency. Field tests and actual performance have demonstrated that the recovery efficiency will vary from 40% to 98% depending on oil viscosity and thickness. Portable rope mops can effectively operate in marshes, shallow water, and water containing debris. During the 1977 Buzzards Bay oil spill cleanup operation, rope mops were able to recover oil from ice-infested waters. In the Beaufort Sea, rope mops can be deployed from barges or boats to clean up oil in offshore waters, trapped between ice floes or in leads. During winter, rope mops can be used to recover oil trapped under ice.

During a field test at Halifax, Nova Scotia, rope mops were able to recover 39.1 liters of oil per minute with a 71% oil/water ratio. Collection efficiency increased with increasing slick thickness. For example, the rope mops yielded a 54.6% oil/water ratio for a 1 millimeter slick and 71.5% oil/water ratio for a 5 millimeter slick.



PORTABLE SKIMMER HEAD



ROPE MOP DEPLOYMENT

Figure 4.4.1.1.1	ROPE MOP SKIMMER

These tests also revealed that rope mops are not affected by wave action. Also, the speed of the rope has to be adjusted to suit the type of material being collected. Additionally, exposure time to the oil is a critical factor for maximizing cleanup efficiency. The greater the exposure time, the greater the absorption per unit length of mop. Rope speed for materials with high viscosity should be low because the transfer time from water to rope surface increases substantially.

Rope mops tend to collect emulsions much slower than fresh oil. Under some circumstances, the rope mop movement on the water surface can contribute to emulsion formation. During one of the tests, 17% of the oil was emulsified during the recovery process.

The Warren Spring Laboratory evaluated rope mop skimmer performance for: 1) diesel fuel with a viscosity of 6.6 centistokes (cSt), 2) Kuwait crude with a viscosity of 34.8 cSt, 3) Kuwait crude with a viscosity of 200 cSt, 4) Kuwait emulsion with a viscosity of 232 cSt, 5) heavy fuel, and 6) Beatrice crude. The rope mop recovered all the test oils except the heavy fuel and Beatrice crude oils. Although the heavy fuel oil was absorbed by the rope mop, it was too viscous to be removed by the rollers. Beatrice oil on the other hand, solidified under the test conditions and could not be absorbed by the mop.

These tests revealed that the mop speed should be reduced as the oil layer thickness decreases. This lowers the amount of surface agitation created by mop movement and allows thin layers of oil to flow towards the mop. Slower mop speeds also increase contact time and decrease the amount of water in the recovered fluid.

The Warren Spring Laboratory tests suggest that the overall recovery rate depends on how fast oil flows towards the mop. Therefore, in thin oil layers, this rate will be less than with thick layers. Additionally, thick rope mops will project further into the water than thin mops. Hence, the recovery rate is not directly proportional to mop size.

During 1983, several oil companies in Alaska conducted a series of tests in the Beaufort Sea to evaluate the feasibility of using rope mop skimmers for oil recovery in ice-infested waters. During these, three rope mop skimmers were deployed from a 200' by 60' barge as shown in Figures 4.4.1.1.2 and 4.4.1.1.3. The three rope mops accumulated a combined skimming time of nearly 17 hours without any mechanical problems (no oil or simulants were used during this test). However, it was necessary to frequently remove the rope mops from the water to prevent them from being snagged and torn by moving, broken ice. It was apparent that this would have decreased the overall effectiveness during an actual cleanup operation. Although rope mop skimmers can be deployed in ice-infested waters, it is questionable how much oil they could actually recover in an offshore environment with moving broken ice.

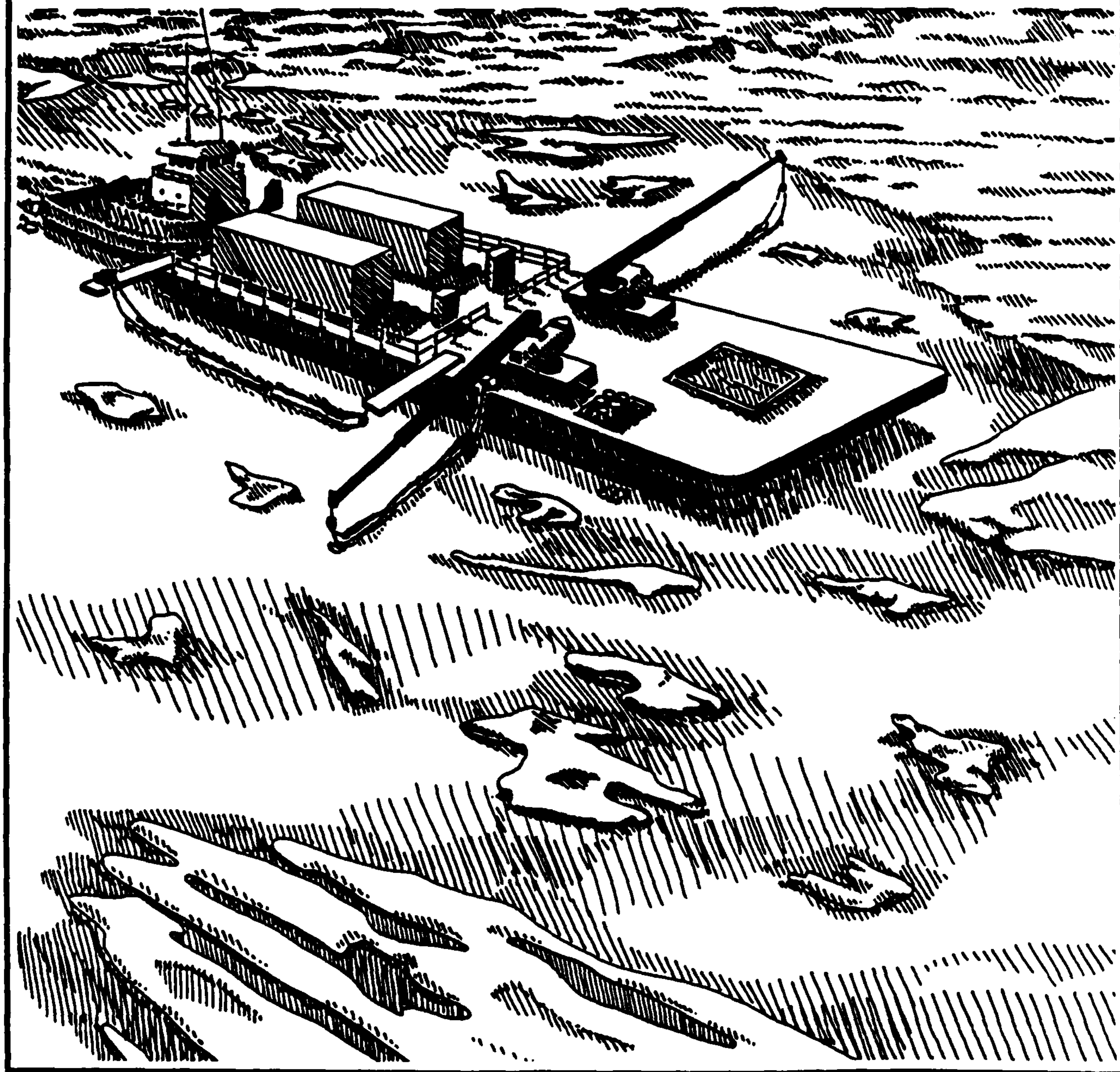


Figure 4.4.1.1.2	ROPE MOP SKIMMER IN BROKEN ICE

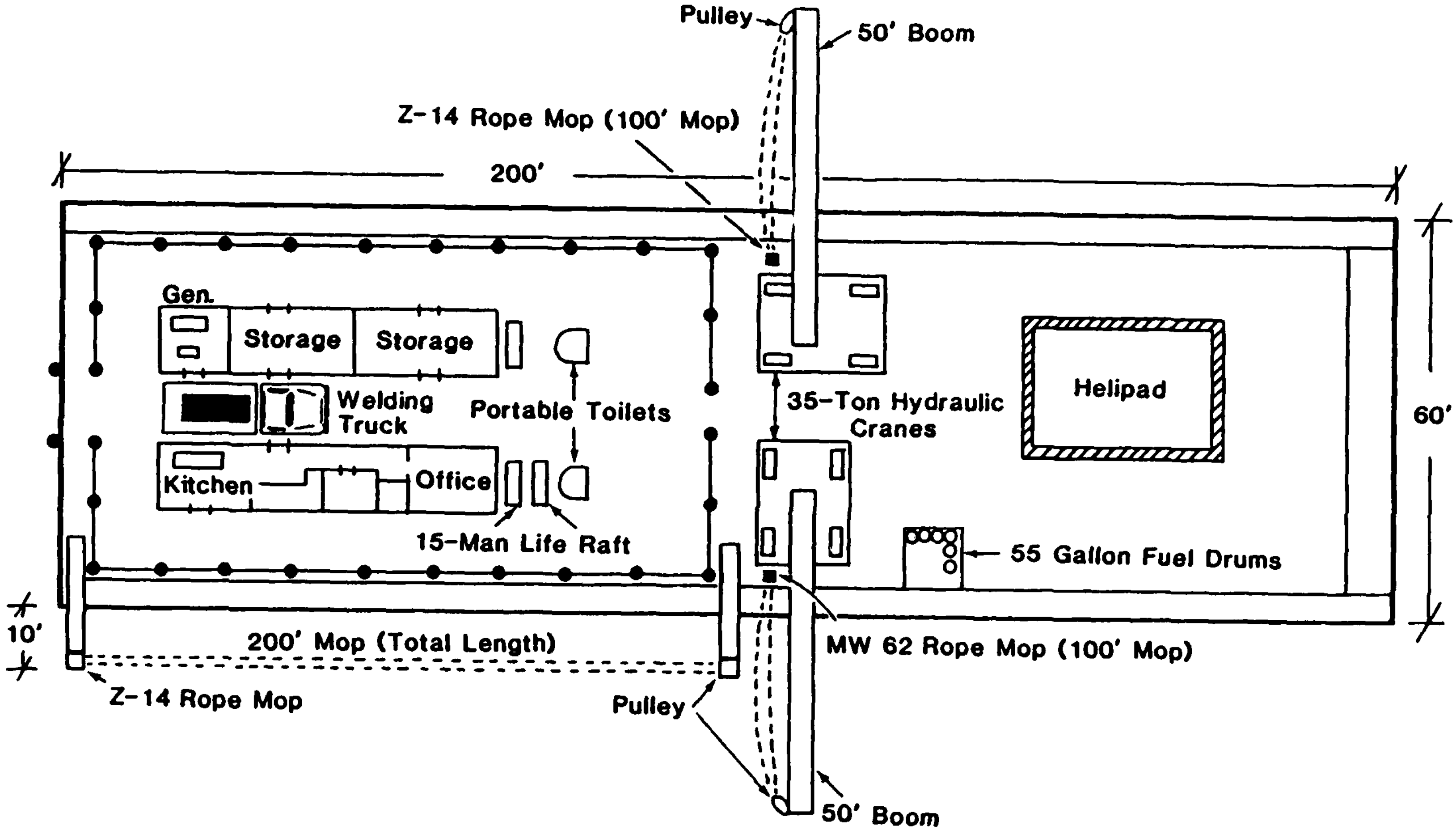


Figure 4.4.1.1.3

PLAN OF BARGE WITH ROPE MOP SKIMMERS

In spite of reduced recovery rates as slick thickness diminishes, rope mops are capable of completely removing many oils on water surfaces. Major advantages inherent to rope mop skimmers are as follows:

- They have a high oil/water pickup ratio.
- They have good performance in waves.
- They are effective in ice-infested water or waters containing debris.
- They are easily repaired and require little maintenance.
- They are very effective in shallow water.

Some of the major disadvantages inherent to rope mop skimmers are:

- They have relatively low pickup rates.
- They are ineffective for oil that is treated with dispersants.
- They are ineffective in emulsified oil.
- They are also ineffective for very viscous oil.

The following portable rope mop skimmers are currently stockpiled in Alaska.

Manufacturer	Model	No.	Maximum Recovery Bbl/hr.	Maximum Wave Height ft.	Maximum Current Knots	Maximum Wind Velocity Knots
Centrifugal Systems Inc.	Z-14	14	10	1	1	20
Oil Recovery International	Barracuda 2000	1	28	1.5	2	12
Containment Systems Corp.	MW62	2	50	N/A	N/A	N/A

4.4.1.2 Weir Skimmers

Weir Skimmers consist of a chamber with a sump and at least one opening that has a weir attached to it. Once deployed, the sump floats several inches below the water surface with the weir positioned above the oil-water interface. Afterward, oil flows over the weir into the sump and is transferred to an external container for temporary storage.

In comparison to other devices for oil spill recovery, weir skimmers are simple and reliable for calm water conditions. For thick oil films (at least 25 mm), weir skimmers can recover oil at oil-water ratios that average 50% oil and 50% water. As the oil film thickness decreases, the oil-water ratio also decreases. For example, for oil thicknesses that range from 1 to 8 mm, the recovery ratio for some weir skimmers will be approximately 10% oil and 90% water.

Weir skimmers are easily plugged by debris, slush ice, or broken ice. Also, recovery efficiency is reduced by waves. During winter, slots can be cut in the ice cover so that weir skimmers can be used to recover oil trapped under it. During freezeup, weir skimmers should be able to recover oil in areas where ice conditions will not cause plugging.

The following Weir Skimmers are stockpiled in Alaska:

Model	Number on Hand
Slurp	11
Acme	2
Manta Ray	11
Skim-Pak	2

4.4.1.2.1 *Slurp Skimmer*

The Slurp is a portable weir skimmer which is 37 inches wide and weighs 62 pounds (Figure 4.4.2.1). It can operate in shallow areas containing as little as 10 inches of water. The depth of the weir is controlled by adjusting the level of fluid in the skimmer's sump. To accomplish this, a variable speed pump is required. If the pump is operated at a high rpm, the liquid level in the sump will be low. Consequently, the position of the weir will be low. On the other hand, if the pumping rate is low, both the sump level and weir positions will be high. For thin oil films, low pump rates would be desirable. For thick oil films, it should be high.

The Slurp Skimmer was tested at the Warren Spring Laboratory with Kuwait crude oil that was 1 to 15 millimeters thick. While operating in a 15 millimeter slick at a pump rate of 10 liters per minute, it recovered 100% oil. In a 1 millimeter slick, 20% oil and 80% water was recovered at the same pump rate. If high water content can be tolerated, the Slurp Skimmer will remove all of the oil from the water surface. This point was established in tests with kerosene, diesel fuel, gas, domestic heating oil, and Kuwait crude.

The major advantages for the Slurp Skimmer are as follows:

- o It is an excellent oil spill recovery device for thick films of oil in calm water.

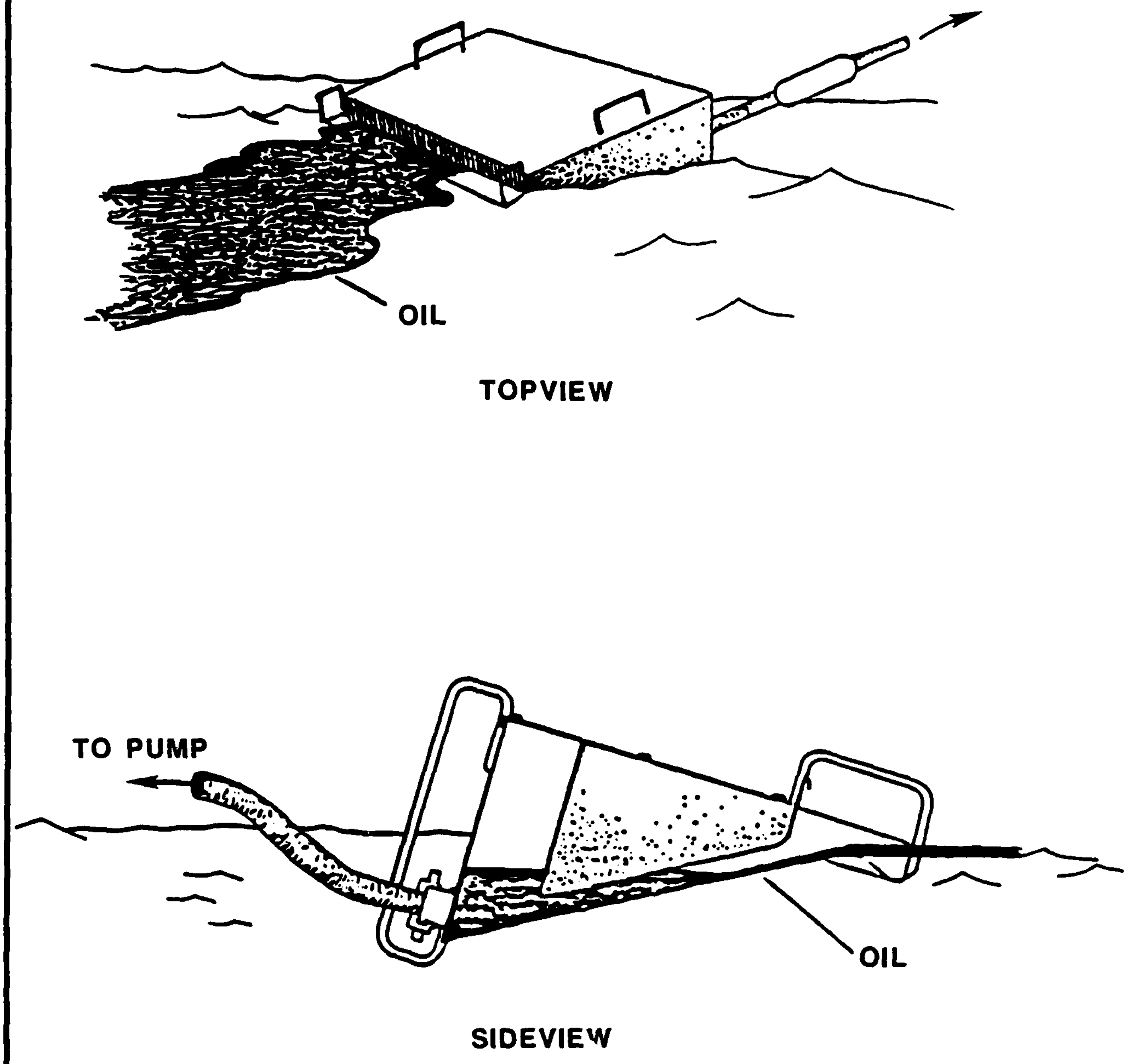


Figure 4.4.1.2.1	SLURP SKIMMER

- It is portable and easily deployed by one person.
- It can be effective for shallow near-shore waters.
- The Slurp Skimmer can operate with a variety of external pumps mounted on shore or a recovery platform.

The primary disadvantages inherent to the Slurp Skimmer are as follows:

- It can recover more water than oil.
- It can be easily plugged by floating debris.
- It is ineffective in water with waves.

The Slurp Skimmer can recover up to two gallons of fluid per minute. However, it has a tendency to emulsify recovered oil and water. This is due to agitation in the skimmer's collection sump and the transfer pump.

4.4.1.2.2 <u>The Skim-Pak</u>

This unit is a portable self-adjusting weir skimmer (Figure 4.4.1.2.2). Oil is removed from the skimming head by an external suction pump or vacuum system. Consequently, it can effectively be deployed from a vessel in ice-infested water.

This unit's principal weakness is that it may collect as much as 75% water with the oil it recovers. However, this should not prove to be a problem if adequate oil/water separation capability exists during the cleanup operation. The Skim-Pak comes with a debris screen which will allow it to be deployed in water containing debris. As shown in Figure 4.4.1.2.2, the Skim-Pak can be deployed as a hand-held unit. As such, it can be easily positioned in areas of high oil concentration to maximize cleanup performance.

4.4.1.2.3 <u>Destroil Skimmer</u>

As shown in Figures 4.4.1.2.3.1 and 4.4.1.2.3.2, the Destroil Skimmer is a submersible weir skimmer. After the oil spills over the weir, it is pumped out of the skimmer's sump by an Archimedes-type screw pump driven by a hydraulic motor. The discharge from the screw pump is transferred to an external storage container through a 20 cm. diameter flexible hose.

A trio of flotation chambers makes it possible for the Destroil Skimmer to float in the water. The power pack for this skimmer includes a diesel motor with a built-in hydraulic tank and air compressor. Once the system is in service, the power pack can adjust the flotation chambers in order to change the position of the weir relative to the oil/water interface. Speed and direction of the screw pump can also be adjusted by the power pack. Three men are required to deploy the Destroil Skimmer.

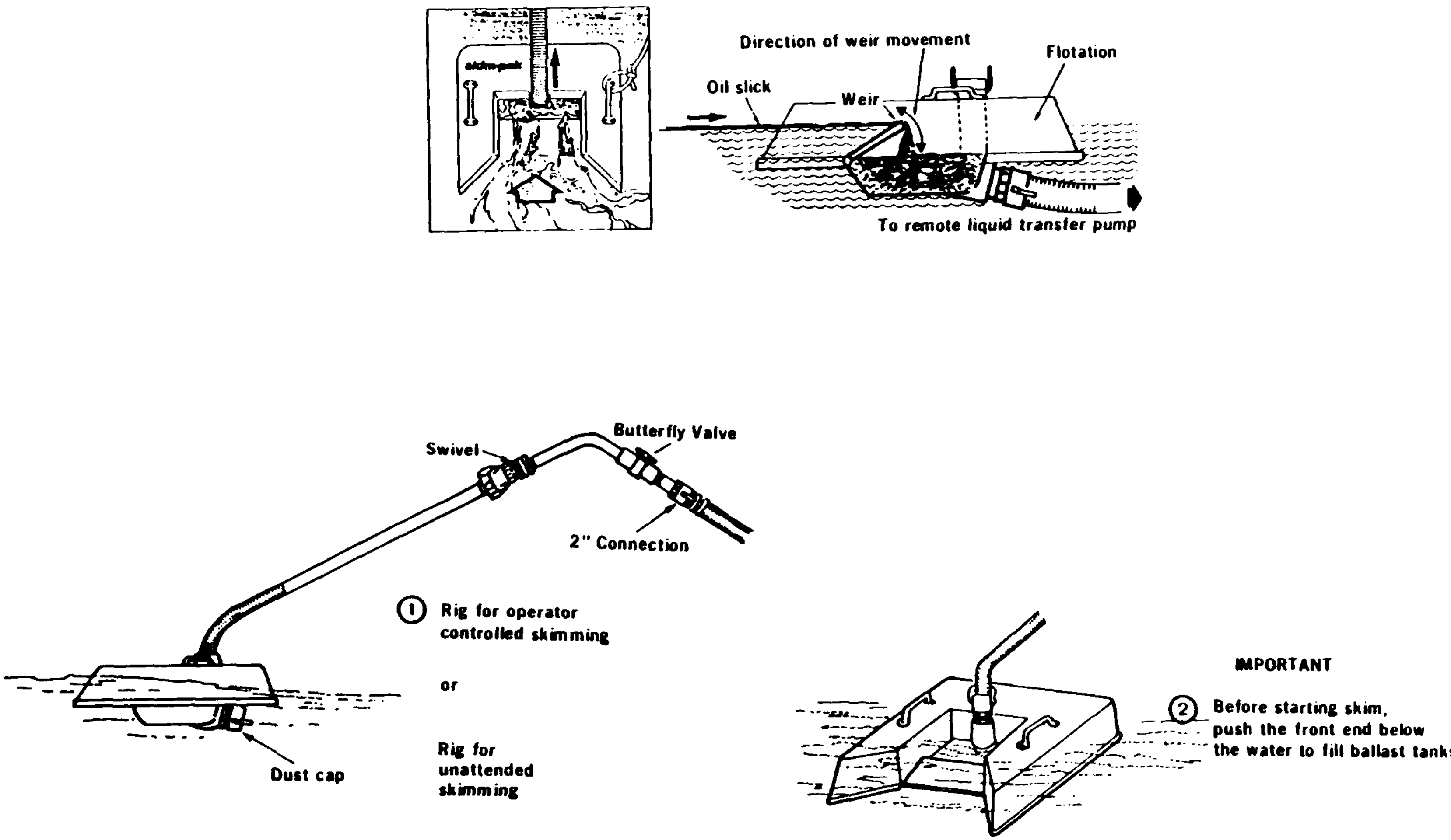


Figure 4.4.1.2.2

SKIM-PAK

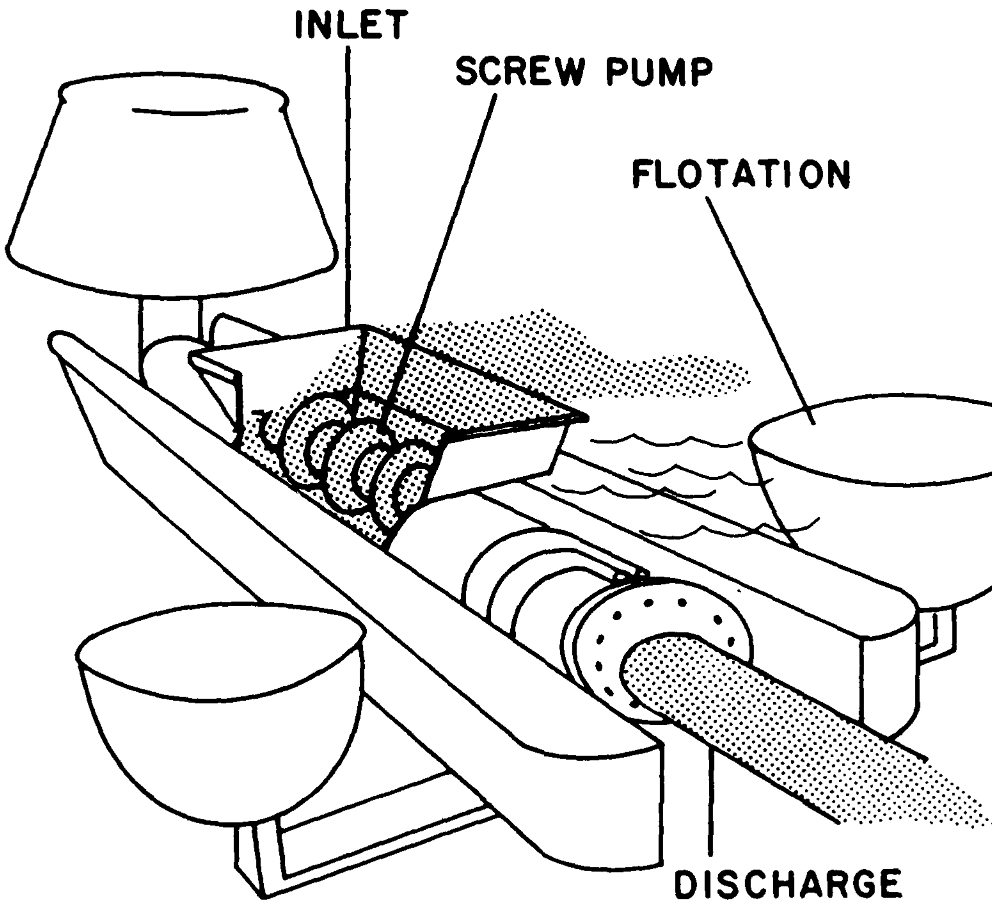
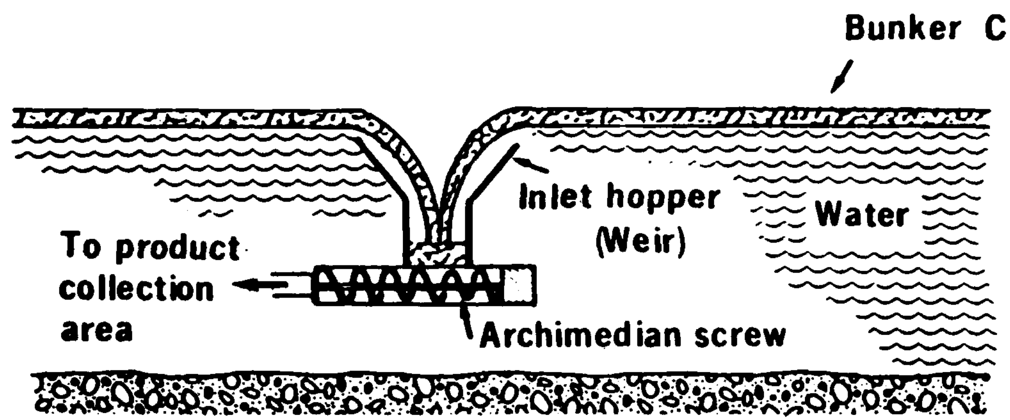


Figure 4.4.1.2.3.1	DESTROIL SKIMMER

The Destroil (Manufacturer: AB Gustaf Terling, Goteborg, Sweden)

Operating Principle and Specifications: As depicted in this Figure, the Destroil employs the weir principle for collecting oil. After the oil has spilled over the weir, it is pumped out of the sump by an Archimedes-type screw pump driven by a hydraulic motor. The discharge from the screw pump is carried away through a 20-cm diameter flexible hose. The unit is kept buoyant by a trio of flotation chambers -- two fixed and one air-adjustable. It comes complete with external power pack, hose reel, and hoses.



The three major components of the system had the following overall dimensions. The shipping dimensions were approximately the same.

	Length(m)	Width (m)	Height (m)	Weight (kg)
Power Pack	1.6	1.0	1.2	900
Hose Reel	1.4	1.46	1.02	Variable
Skimming Head and Floats	2.5	1.7	0.9	190

Figure 4.4.1.2.3.2 **DESTROIL: COLLECTION WEIR AND ARCHIMEDIAN SCREW FOR TRANSFER**

During 1980, the Destroil Skimmer was tested in a settling pond with Bunker C fuel oil at Holyrood, Newfoundland, Canada. Due to its high viscosity, the Bunker C (viscous oil) would not flow over the weir at a significant rate. When the unit was first started, the oil immediately above the weir flowed into the skimmer's sump and was transferred by the screw pump without problems. However, it was impossible to regulate the weir height so that a continuous inflow of oil could be achieved. If the weir was submerged to the point where there was a rapid flow of oil over the weir, excess water was collected. If the weir was raised to limit the water inflow, the oil would not pass over the weir due to its high viscosity.

The skimmer's flotation cylinders created a blockage which restricted the ability of the incoming oil to reach the weir. This, in part, was due to the viscosity of the oil which was tested. Thinner oils would flow readily into the weir and this problem would not be observed.

Although this skimmer is capable of transferring very viscous oil, it is not capable of effectively separating oil and water. Therefore, it is not suitable for thin oil films on water or heavy oils which are not free flowing. Also, since it is a submersible skimmer, it is not suitable for deployment in water with moving ice.

Alaska Clean Seas has one Destroil pump. It does not have the attachments necessary to make this pump work as a floating, skimming unit. However, it can be completely submerged in a pool or container of viscous oil. Afterwards, it could pump this oil to other locations as desired.

4.4.1.2.4 U.S. Coast Guard Skimming Barrier

The U.S. Coast Guard Strike Teams have a total of 24 oil spill skimming barriers. These barriers were manufactured by Offshore Devices, Inc. and use weirs for oil spill recovery. During 1977, tests at EPA OHMSETT revealed that this skimming system achieved high oil recovery efficiencies when towed at low speeds in calm water (Figure 4.4.1.2.4). However, performance decreased when it was tested in water with waves.

The sea-keeping ability of the skimming barrier was commendable under most test conditions. However, there was considerable oil loss under the barrier at higher tow speeds that were not attributable to the OHMSETT tank wall effects. Although the system performed well, several seals in the pumps and manifold-flow divider for the hydraulic fluid system had to be replaced.

4.4.1.3 The ARCAT Skimmer

The ARCAT Skimmer (Figure 4.4.1.3) is a self-propelled catamaran vessel designed to clean up oil spills in ice-infested water and

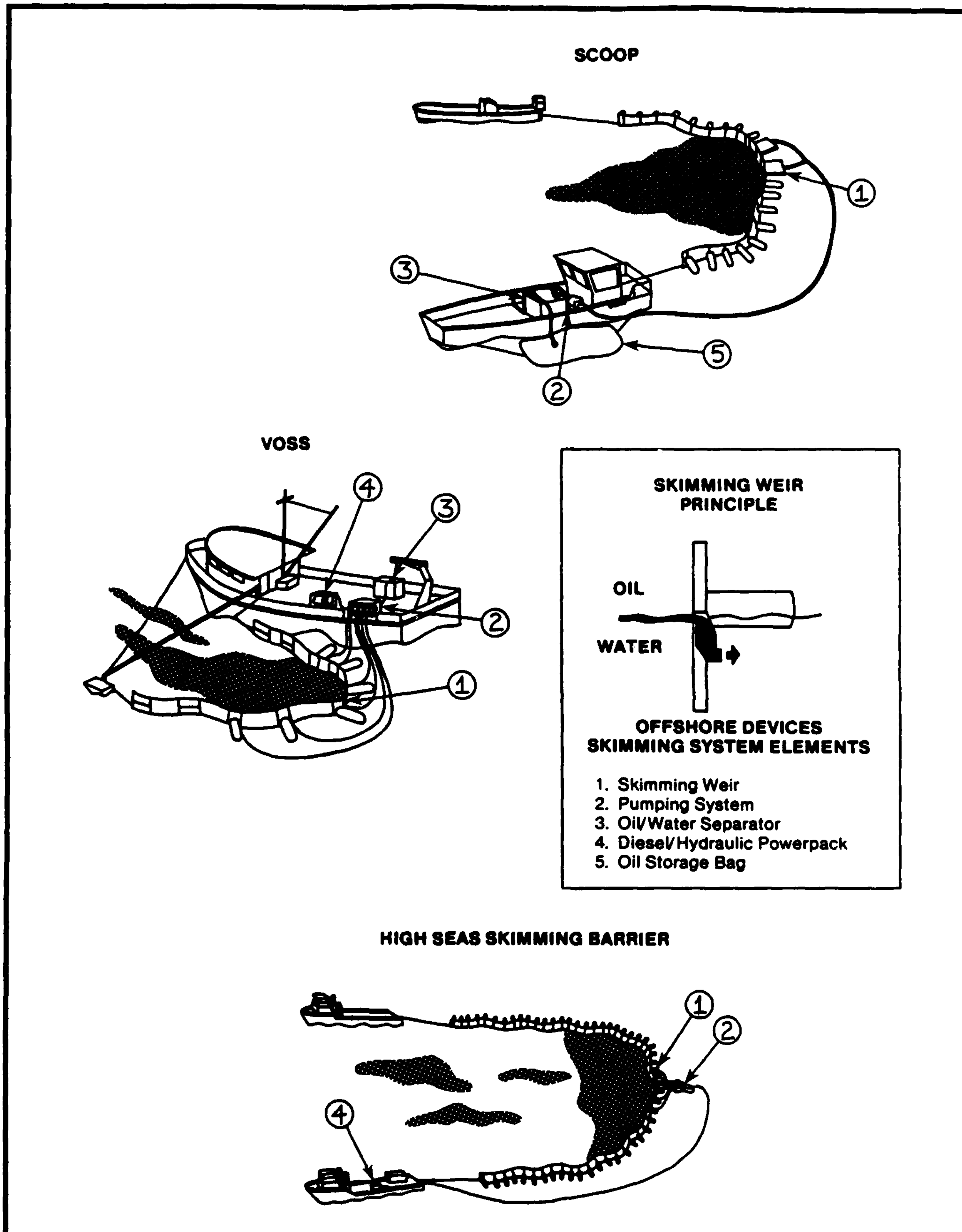


Figure 4.4.1.2.4	COAST GUARD SKIMMING BARRIER

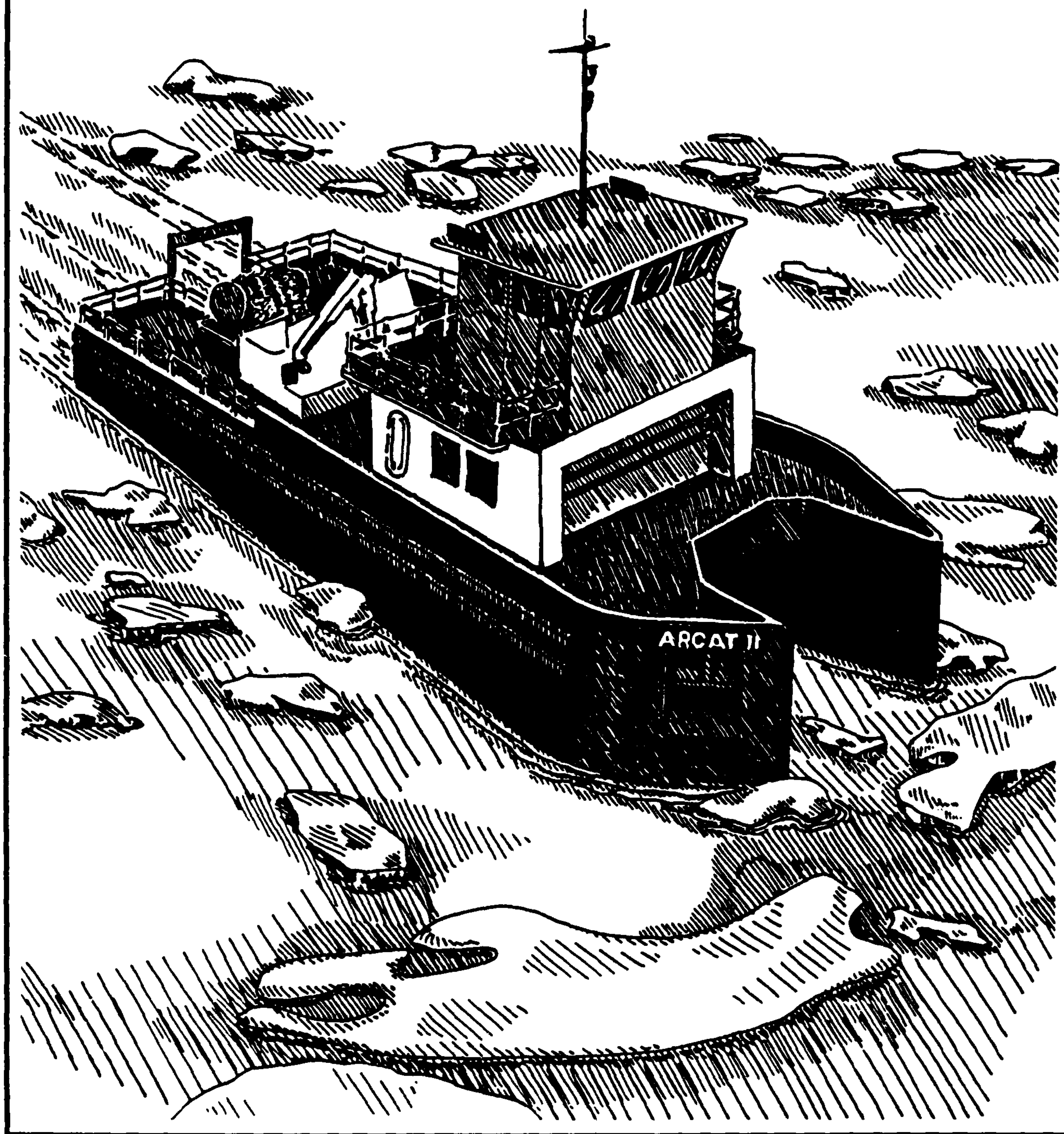


Figure 4.4.1.3	**ARCAT SKIMMER**

in seas up to three feet. It is a 65 feet long, 22 feet wide ABS Class B ice-strengthened vessel. The operating draft for the ARCAT is 6.2 ft. Its maximum speed is 8.5 knots.

The ARCAT has a rope mop skimmer and a rear-mounted weir skimmer for oil spill recovery. The rope mop skimmer is mounted between the catamaran hulls and has a variable speed drive. This allows it to rotate at speeds equal to the vessel's forward velocity, thereby maximizing contact time between the rope mop and the oil slick. The weir skimmer, located between the catamaran hulls, can be used to rapidly clean up thick layers of oil. Under optimum conditions (calm, ice free waters), the ARCAT Skimmer may be able to recover up to 500 Bbls. of oil per hr., providing booms are used to increase its oil encounter rate.

The ARCAT Skimmer has two 90-barrel oil storage tanks, each connected to a separate transfer pump. Both pumps operating together should be able to off-load recovered oil at a rate of 250 Bbls. per hr. The ARCAT Skimmer has quarters (shower, kitchen, and sleeping area) which will accommodate a four-person crew.

During the summer of 1983, field tests were conducted for the ARCAT Skimmer in the Beaufort Sea to determine how well it can maneuver in ice infested water. During eight hours at sea, the ARCAT effectively maneuvered in water containing up to 88% broken ice. While operating in these conditions, it achieved speeds up to 2½ knots. Throughout this test, the ARCAT's rope mop skimmer was not damaged by ice which passed through the vessel's catamaran hull.

Based on its design specifications and demonstrated performance, the ARCAT Skimmer has the following advantages:

- It is a self-contained, mobile skimming vessel.
- It is equipped with dual skimming systems (rope mop skimmer and weir skimmer).
- It can operate in water containing broken ice.
- It is capable of deploying chemical dispersants.
- It is equipped with two fire monitors which can be used to herd oil or deploy dispersants.
- It has living quarters that can accommodate 4 people.
- It has two 90-barrel recovered oil storage compartments equipped with heating systems.
- It is equipped with electronic gear to allow navigation in dense fog.

The primary disadvantages of the ARCAT Skimmer are as follows:

- o Due to its 6.2 foot draft, it can not access many near-shore regions along the Beaufort Sea coastline.
- o Beaufort Sea ice conditions limit the ARCAT Skimmer's operating window to early July through mid-September.
- o The rope mop system may not be able to recover: 1) oil treated with dispersants, 2) emulsified oil, or 3) heavily weathered oil or viscous burn residue.
- o The ARCAT Skimmer may not effectively recover oil in water with waves greater then three feet or water with moving, broken ice.

4.4.1.4 Disc Skimmers

4.4.1.4.1 Komara Miniskimmer

The Komara Miniskimmer is a circular platform which contains 32' plastic recovery discs (Figure 4.4.1.4.1). The discs rotate upwards through slots where oil is removed by plastic scraper blades. The clean surface of the discs rotates downward through the oil and the recovery process is repeated. The recovered oil from the discs flows into an internal reservoir. From here, it is pumped to an external storage container.

The Komara Miniskimmer is equipped with a 5-horsepower Petter diesel engine fitted with a spark arrester and overrun valve. The engine powers a Spate 3B induced flow pump for moving the recovered oil, and a Reyrolle A70 pump to supply hydraulic fluid to the twin Danfoss OMP 50 hydraulic motors which rotate the disk.

The Komara Miniskimmer, manufactured by British Petroleum Co., Ltd., was tested at EPA OHMSETT during 1976. These tests demonstrated that the oil collection rate for this skimmer is independent of disc speed. Yet, the collection efficiency decreased as disc speed increased. Waves with a normal height of 0.15 meters slightly increased the oil collection; however, they decreased the collection efficiency.

The maximum recovery rate for the Komara is 17 tons per hour for Kuwait crude oil with a viscosity of 39 cSt when tested in 78 millimeters of oil. The disc speed for this recovery rate was 135 revolutions per minute. When the disc speed was increased, water content in the recovered fluid also increased.

The Komara Skimmer requires at least 20 millimeters of oil for effective performance. Therefore, complete removal of oil may not be practical with this skimmer. In other words, the Komara Skimmer is not suitable for the thin slicks. Where possible, boom should be used in conjunction with this skimmer to maximize oil thickness.

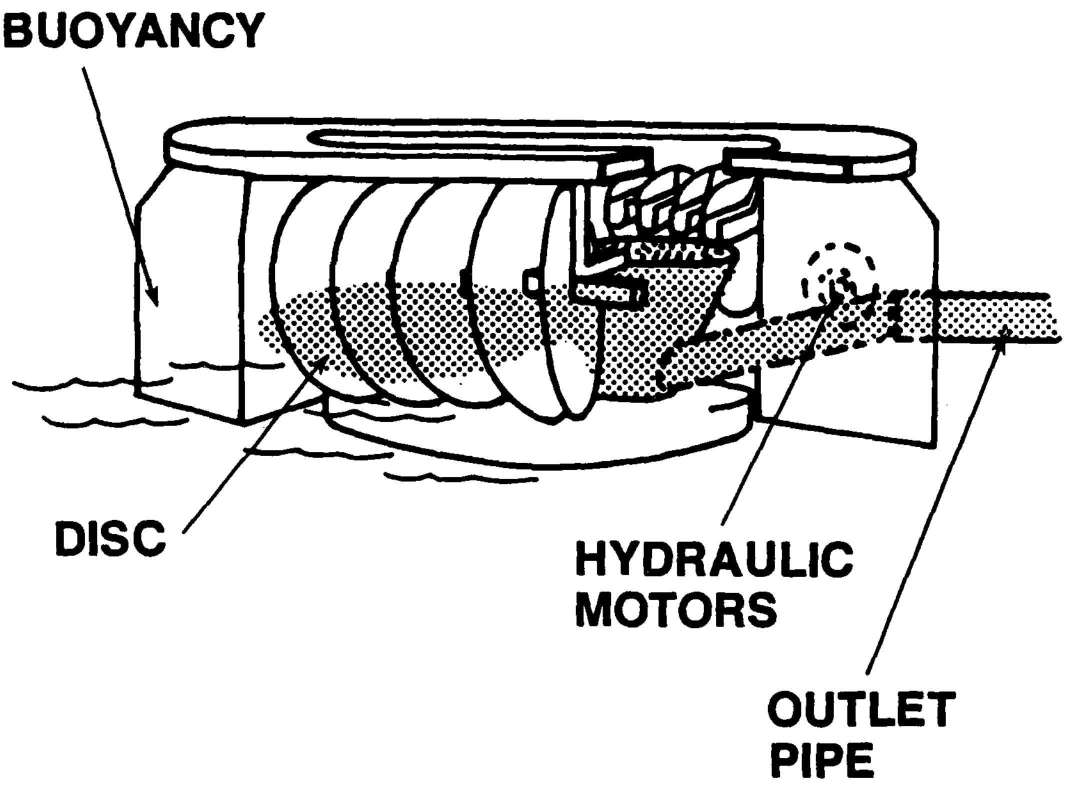


Figure 4.4.1.4.1	KOMARA MINISKIMMER

4.4.1.4.2 Morris MI-30 Disc Skimmer

The Morris MI-30 disc skimmer is a floating oil spill recovery device equipped with 30 polyvinyl chloride discs that are rotated by an internal hydraulic motor (Figure 4.4.1.4.2). The discs are mounted on three shafts that form a triangle which is parallel to the water surface. As the discs contact the spill, oil adheres to them and is subsequently removed by stationery blades that continuously wipe the disc. The removed oil is collected in an internal sump and transferred to external storage containers by a hydraulic pump. Field tests performed by Environment Canada demonstrated that this skimmer can recover crude oil at rates up to 8 Bbls. per hour in open water.

Although the Morris MI-30 Disc Skimmer has a high recovery efficiency (95% oil and 5% water), its recovery rate tends to be low. Additionally, it is susceptible to clogging or damage by debris or floating ice. Alaska Clean Seas has one Morris MI-30 Disc Skimmer.

4.4.1.5 Vacuum Skimmers

4.4.1.5.1 Trans-Vac Oil Recovery System

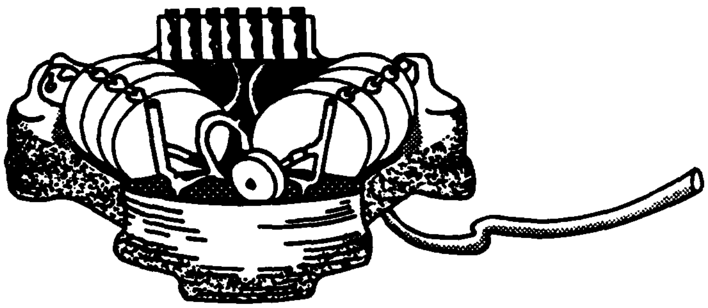
The Trans-Vac is a portable vacuum system which consists of two water-cooled diesel engines, two positive displacement pumps, a 500-gallon holding tank, and a control panel. This system is capable of recovering up to 700 Bbls. of fluid per hour.

The holding tank is equipped with a screen that prevents discharge line from being plugged with ice or debris that may be collected by the Trans-Vac.

Due to its size (12 ft. x 7 ft. x 7 ft.) and weight (5,500 lb.), a forklift is required to move a Trans-Vac. This recovery system is usually deployed from barges, flat beds, or low-boys to clean up spills along shorelines or recover oil trapped under ice during winter. They can also be deployed from rolligons to clean up oil on tundra. Usually a weir skimmer (Manta Ray) is used with a Trans-Vac to minimize the amount of water that is collected.

4.4.1.5.2 Vacuum Trucks

Vacuum trucks can be very effective for cleaning up oil spills. For offshore response operations, they can be transported to the spill location by barges. A number of vacuum trucks are located at Deadhorse, Alaska and would be available for oil spill cleanup operations.



SIDEVIEW

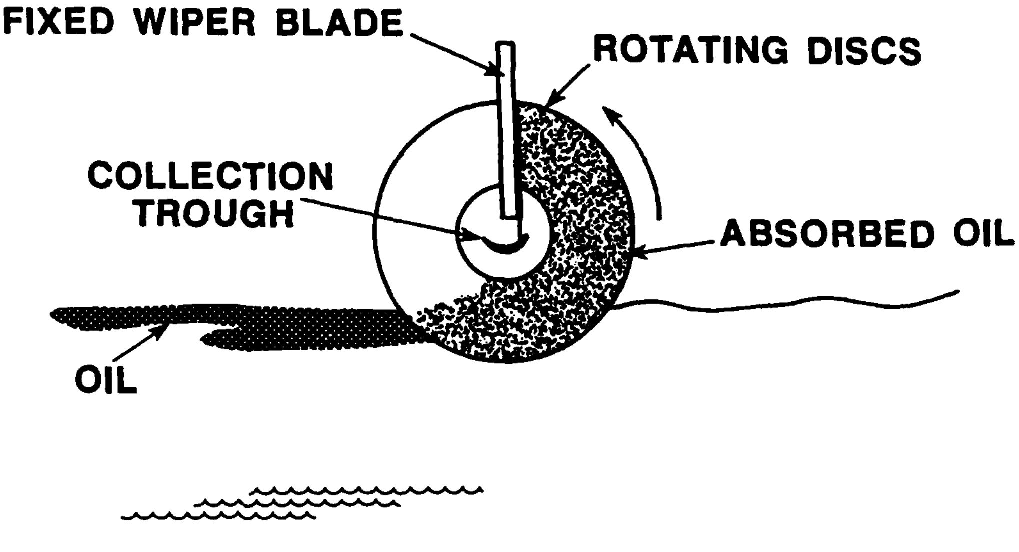


Figure 4.4.1.4.2	MORRIS MI-30 DISC SKIMMER

4.4.1.6 Induced-Flow Skimmers

4.4.1.6.1 Walosep Skimmer

The Walosep is a unique device for cleaning up offshore oil spills. This unit includes a floating skimmer, hydraulic pump, and a power pack. As shown in Figure 4.4.1.6.1, the skimmer has a series of rotating vanes which draw oil and water towards it. Once the oil reaches the skimmer, it is forced under the stator and into an inverted sump. From there the oil is withdrawn through a submerged hose connected to the hydraulic pump located on shore or a vessel of opportunity.

The Walosep is rather unique in that it creates a current which causes an oil slick to flow towards it. As result, it has a high oil encounter rate (quantity of oil recovered per unit of time in service) while operating in a stationary position.

During 1979, the Walosep was tested by the EPA at its oil and hazardous material simulated environmental test tank in Leonardo, New Jersey. When exposed to a 5 mm (0.2 in.) slick in 0.49 m (1.6 ft.) waves, it was able to recover 97 cubic meters of oil per hour (610 Bbls. of oil per hour). During this test, the recovered fluid contained 78 percent oil and 22 percent water. Also, 59 percent of the oil in the test tank was recovered.

The Walosep is ideally suited for cleaning up oil in water containing large pieces of broken ice. The skimmer has a lifting ring which can be attached to a crane. Afterwards, the crane (located on a barge or other suitable vessel) can readily deploy and remove the skimmer from the water to avoid contact with moving ice. Since the Walosep has high encounter rates and oil/water recovery ratios, it should perform much better than rope mop or weir skimmers in water containing broken ice.

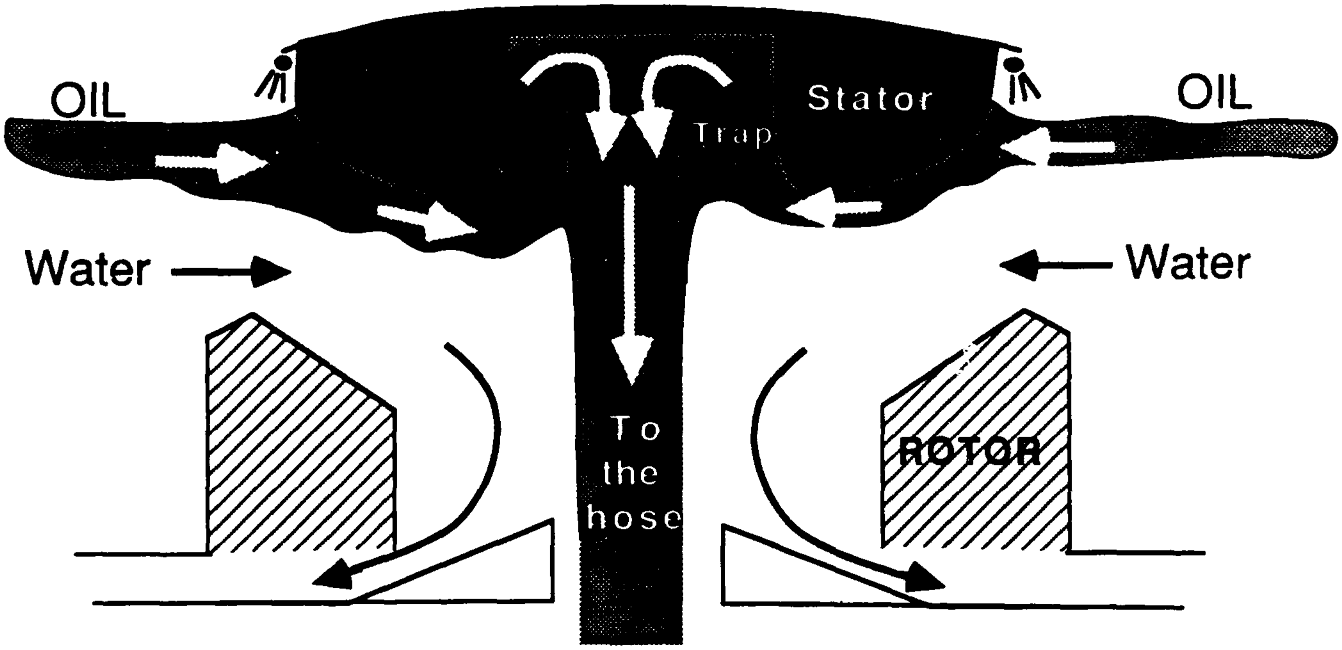
The Walosep is not suitable for deployment in water containing small pieces of ice or debris which could create a barrier around the stator or plug the transfer hose.

Currently, three Waloseps are stockpiled in Alaska. One is owned by Alaska Clean Seas. Two are owned by Sjit Shah, Inc.

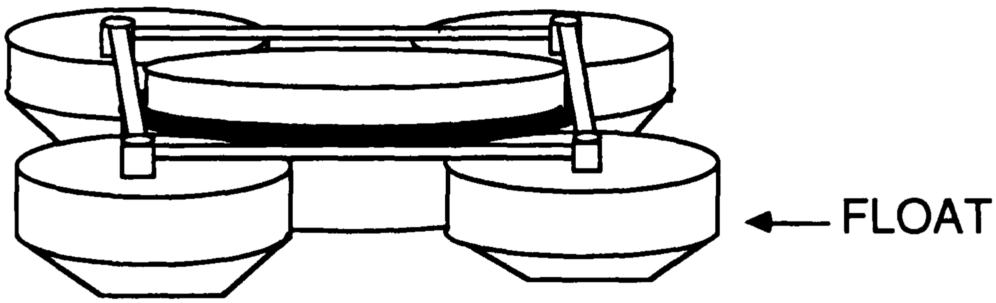
4.4.1.6.2 Pickup Pollution Machine

The Pickup Pollution (PUP) Machine is an excellent device for cleaning up oil in shallow water. It consists of a small catamaran float, boom, pump, weir, and water jet. As shown in Figure 4.4.1.6.2, the pump is located on the float, while the water jet and the weir are positioned between the catamaran's pontoons. The boom is used to create a containment pond at the aft end of the float.

When this unit is placed in service, the pump forces water through the spray jet. In response to this, the spray jet

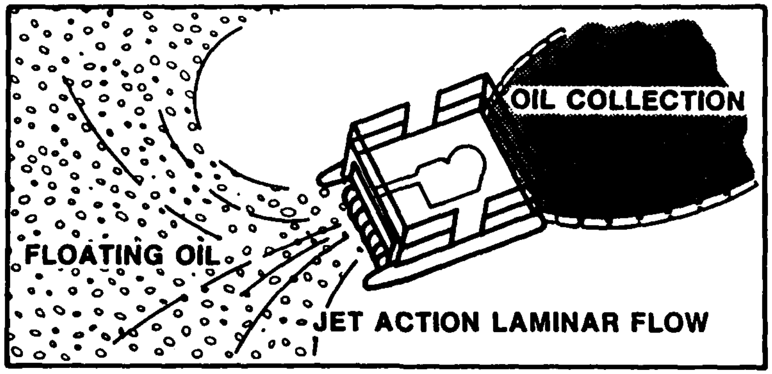


CUTAWAY VIEW



SIDE VIEW

FIG. 4.4.1.6.1	**WALOSEP SKIMMER**



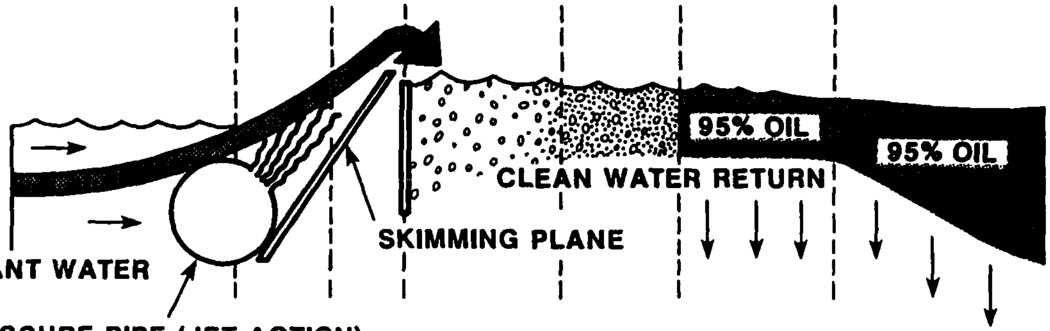


Figure 4.4.1.6.2

PICKUP POLLUTION MACHINE

creates a current which draws oil towards the PUP Machine. The spray jet also lifts the oil over the weir and herds it to a containment pond behind the float. From there, the oil can be pumped to storage containers located on shore or on offshore vessels.

The primary limitation inherent to the PUP Machine is that it does not have any provisions for transferring oil to a storage container. However, this can be resolved by placing a skimmer inside of the collection boom. Another limitation is that the PUP may not perform well in water with waves greater than 0.45 m (1.5 ft.).

The primary advantage of the PUP Machine is that it has a shallow draft (10 to 20 cm or 4 to 8 in.). Consequently, this device may prove to be very effective in coastline areas where the water depth is less than 1.8 m (6 ft.) deep. Once deployed in a stationary position, the PUP Machine is capable of collecting oil slicks which are spread over a large area.

The PUP Machine is manufactured by Price-Darnell of Alabama, Inc. (205/661-6612). Currently, there are no PUP Machines in Alaska.

4.4.1.7 Sorbents

Sorbents are made of synthetic material, such as polyurethane or polypropylene, which recovers oil by adsorption and absorption. Adsorption occurs when oil adheres to the material's surface by molecular forces. Absorption occurs when oil is trapped in the pore space between the material's fibers. These processes give sorbents the ability to recover from 10 to 26 times their weight in oil without collecting much water. Sorbents are made in a number of sizes and shapes, including booms, pillows, sheets, and particles.

Sorbents are ideally suited for cleaning up small spills and oil sheens. They can be used to recover oil and reduce oil spreading during any season. Sorbents can be readily disposed of by burning. Under the proper conditions (excess air and controlled water injection), oiled sorbents will burn without emitting black smoke.

The following sorbent inventory is owned by industries in Alaska:

Manufacturer	Type	Quantity	Maximum Sorptive Capacity
3M	280	45,000 ft. (Boom)	16.2 lb/ft.
3M	100	2,900 Rolls	300 oz/yd^2
3M	157	6,500 Bales	300 oz/yd^2
3M	151	269 Bales	150 oz/yd^2
3M	356	585 Boxes	--

4.4.2 Shoreline Cleanup

Due to the location of the Arctic ice pack, drilling operations in the Beaufort Sea usually occur within 20 miles of shore. Therefore, if a large offshore spill were to occur during breakup or the open water season, it is reasonable to assume that sections of the Alaskan Beaufort Sea shoreline could be coated with oil. Although the exact locations and time of impact would depend on wind speed and direction, considerable effort may be required to clean up oil spills on the northern coast of Alaska.

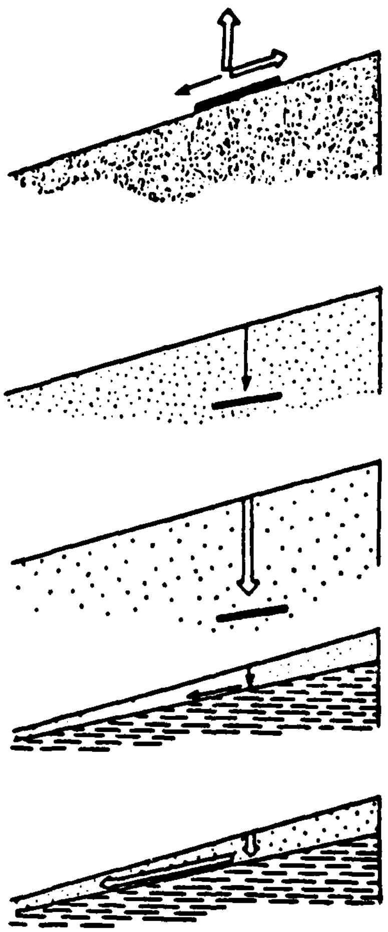
This section of the Planning Guide provides the On-Scene Coordinator with information regarding the techniques and logistical requirements for shoreline cleanup in the Beaufort Sea region. It is important to recognize that under some circumstances, it may be prudent to give shoreline cleanup and protection a higher priority than offshore response. For example, if the spill will contact shore before offshore containment can be achieved, shoreline cleanup should receive a higher priority if:

- The oiled area is a critical wildlife habitat.
- Offshore cleanup will not be effective or prevent significant quantities of oil from contacting the shore.
- The Regional Response Team determines that the environmental impact would be greater if shoreline response is delayed.

4.4.2.1 Considerations for Shoreline Response Priorities

Based on previous experience, it is possible for a large spill to contaminate many miles of shoreline. This was demonstrated in 1979 when oil from the Ixtoc 1 Blowout in the Gulf of Mexico coated 50 miles of the Texas shoreline. Since it is unlikely that resources would be available to immediately respond to every mile of oiled shoreline, it is important to establish response priorities.

A good understanding of oil penetration and retention is essential for establishing shoreline response priorities. The degree to which oil will penetrate a shoreline depends primarily on the permeability of the sediment and the viscosity of the oil. Gravel beaches, for example, have high permeability and are easily penetrated by light to heavy weight oils. On the other hand, fine sandy beaches and mud flats are not easily penetrated by many oils. This is especially true if these beaches are wet prior to contact with oil. Oil penetration depths for various beach sediments are shown in Figure 4.4.2.1.



	OIL PENETRATION		
SUBSTRATE	DEPTH	AMOUNT	OIL FATE
SILT VERY FINE SAND	NONE	NONE	HIGH INTERTIDAL WATER
FINE SAND	SHALLOW	MODERATE	BEACH LAYER
COARSE SEDIMENTS	DEEP	LARGE	BEACH LAYER
FINE SAND OVER SHALLOW IMPERMEABLE BASEMENT	SHALLOW	MODERATE	SUBTIDAL SEDIMENTS
COARSE SEDIMENTS OVER SHALLOW IMPERMEABLE BASEMENT	SHALLOW	LARGE	SUBTIDAL SEDIMENTS

Figure 4.4.2.1

PENETRATION OF OIL FOR VARIOUS BEACH SEDIMENTS

Oil retention is governed by the rate at which environmental factors remove oil from a given shoreline. These factors include wave energy, natural erosion, tidal action, evaporation, and biodegradation. Areas which experience high wave energy or high natural erosion should be given a lower priority for response because these processes will eventually force the oil into the water column where it will undergo biodegradation. By comparison, oil retention will be high in calm shoreline areas which do not experience high wave energy. Therefore, these areas should receive higher priorities for protection and cleanup. Table 4.4.2.1 summarizes oil retention for various shoreline types.

Table 4.4.2.1

OIL RETENTION FOR VARIOUS SHORELINES

SHORELINE TYPE	RETENTION POTENTIAL
Exposed rocky headland	Low. Wave action will minimize oil contact. Low priority for cleanup.
Wave-cut platforms	Low. Wave-induced erosion will remove oil in several weeks. Low priority for cleanup.
Exposed fine-medium grained sand beaches	Moderate. Oil may be retained for months. Moderate priority for cleanup.
Coarse-grained sand beaches	Moderate. Oil may be retained for months. Moderate priority for cleanup.
Exposed tidal flats	Low. Low priority for cleanup.
Exposed mixed sand and gravel beaches	Low. Most oil naturally removed in several months. Low priority for cleanup.
Gravel beaches	High. High priority for cleanup.
Sheltered mixed sand and gravel beaches	High. Oil may persist for years. High priority for cleanup required.
Exposed tidal flats - vegetated	Moderate. Oil may persist for a year. High priority for clean-up.
Sheltered rocky coasts	High. Oil may persist for many years. High priority for cleanup.
Sheltered tidal flats	High. Removal of oil necessary. High priority for cleanup.
Salt marshes	Very high. Oil may persist for several years. Cleanup required. High priority for cleanup.

4.4.2.2 Shoreline Cleanup Techniques

Whenever an offshore spill occurs, it will immediately begin to evaporate. Even under arctic conditions, 20 to 50 percent of some oils will evaporate in 24 hrs. Therefore, portions of the spill which contact shore are likely to be very viscous. In some cases, viscous oils will form tar balls prior to coming ashore.

Portable skimmers and sorbents are the primary techniques for cleaning up low viscosity oil in waters along the Beaufort Sea shoreline (Figure 4.4.2.2.1). In areas where a spill has contaminated a marsh or peat beach, low pressure water flush can be used to herd the oil to locations where it can be easily recovered with portable skimmers and sorbents.

Manual removal is probably the best approach for cleaning up oil which has contaminated small sections of the shoreline. This is generally the case in remote areas which can only be accessed by helicopters or by foot. This technique can also be used to remove viscous oil, tar balls, and burn residue from near-shore waters.

Manual removal entails using hand tools such as rakes, shovels, and pitchforks to clean up an oil spill or contaminated soil. It also entails the use of shears or scythes to remove oiled vegetation. Under optimum conditions, each person on a cleanup crew should be able to remove up to 160 pounds of oiled material (sand, tar balls, vegetation, or drift wood) per hour. All recovered material should be placed in leak-proof containers to avoid future contamination.

Heavy equipment is recommended for cleaning large sandy beaches which are coated with oil. For example:

- Motorized graders can be used to scrape up thin layers of oiled sand. Care should be exercised so that the grader's blade will not penetrate more than a few millimeters below the depth of the oil contamination.

  Some contingency plans suggest that graders should be used to push oiled beach sediment into the surf. This technique is not recommended because the oil may eventually recontaminate the beach or other areas along the shoreline.

- Front-end loaders can be used to pick up oiled material which has been pushed together by motorized graders. They can also scrape oiled beach sediment when the oil penetration is too deep to be removed by motorized graders. Front-end loaders are frequently used in conjunction with dump trucks which take the oiled material to a storage or disposal site.

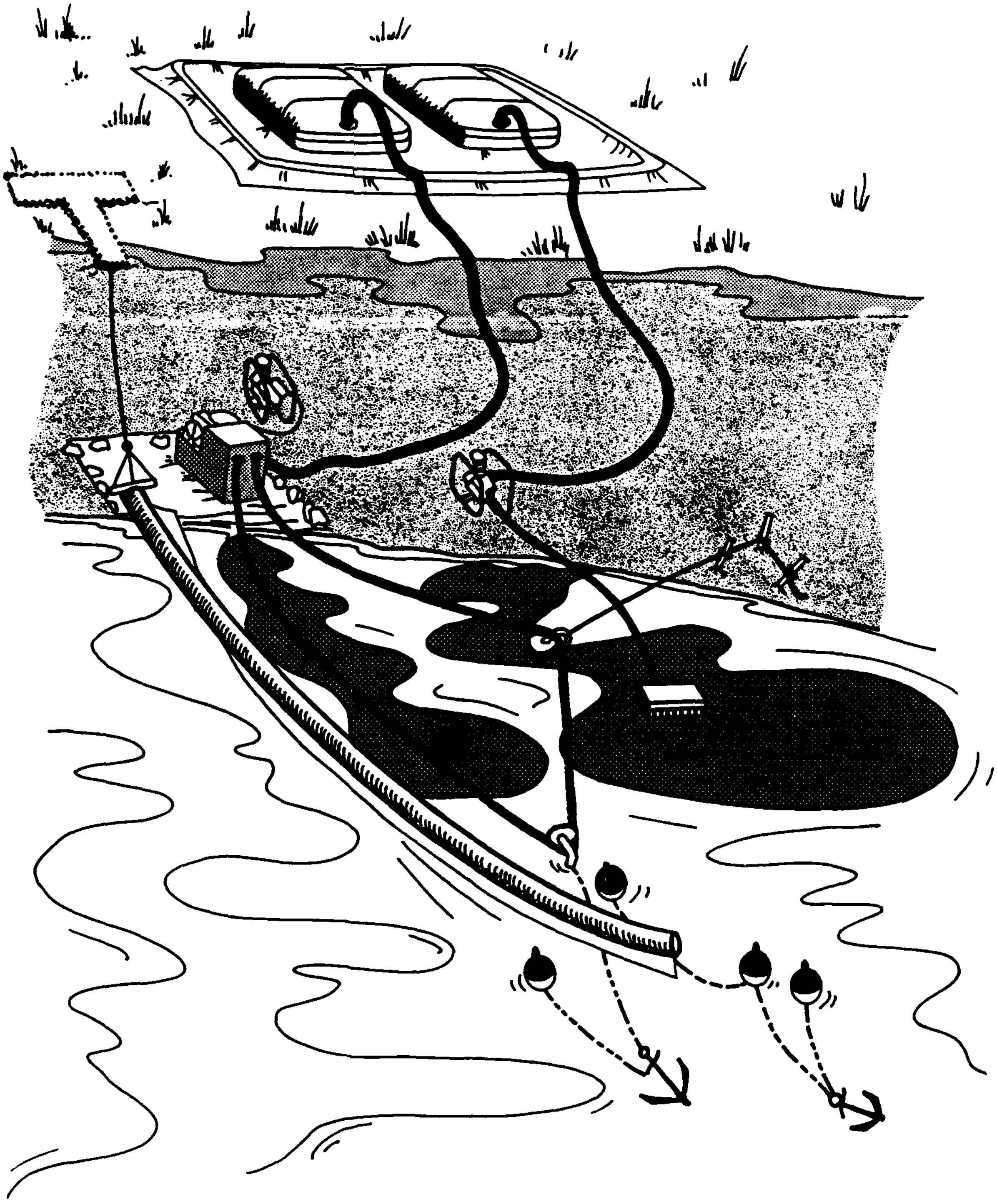


Figure 4.4.2.2.1	SHORELINE CLEANUP TECHNIQUES

- <u>Bulldozers</u> are effective for cleaning shorelines which are not firm enough to support graders or front-end loaders. For the best result, bulldozers should be used to push oiled material to a location where it can be picked up by a front-end loader or personnel with shovels.

The primary limitation for using heavy equipment in the Beaufort Sea region is that there is frequently no means to transport this equipment to remote locations. If the nearshore waters are less then 3 ft. deep, it may be impossible to get a barge close enough to shore to off-load this equipment. Although heavy equipment can be transported by large cargo aircraft, it may be impossible to find a suitable landing strip close enough to the contaminated area. (Heavy equipment should not be allowed on wet or frozen tundra without federal and/or state permits.)

4.4.2.3 <u>Guidelines for Shoreline Cleanup</u>

Guidelines for shoreline cleanup are listed in Table 4.4.2.3. Prior to implementing a shoreline response operation, it is suggested that the On-Scene Coordinator (OSC) obtain input from the Alaska Regional Response Team (RRT). It would also be appropriate for the OSC to obtain the landowner's approval prior to beginning the cleanup operation.

In sensitive shoreline areas where the cleanup operation will do more damage to the environment than the oil, it may be prudent to take limited or no action. Also, in remote areas where the spill will not threaten human health or jeopardize wildlife, subsistence haul-out areas, or cultural resources, it may be advantageous to limit the cleanup operation. However, this decision should be based on input from the RRT, landowner, and the local government which has jurisdiction over the area.

Sand, gravel, or marsh areas can be flooded with water to allow oil to float to the surface. Afterwards, the oil can be recovered with portable oil skimmers and sorbents. If properly implemented, this technique should allow efficient recovery with minimal impact to the environment.

The primary limitations associated with this technique are: 1) it is very slow and tedious; 2) it is labor-intensive; 3) it will not remove oil from vegetation, and 4) it will not remove oil that is absorbed into gravel, sand, or soil. Additionally, this technique would not be effective under conditions which would cause water to freeze.

For marshes and shorelines with heavy vegetation, a low pressure water spray from a hand-held hose can be used to herd oil to a convenient location where it can be contained and recovered. High pressure water spray can be used to remove oil from the hulls of vessels, rocky shorelines, or man-made structures. High or low pressure flushing is an efficient means for onshore oil spill cleanup. However, this technique must be used with a skimmer or sorbent material to recover the oil.

Table 4.4.2.3

SUMMARY
OF
SHORELINE CLEANUP GUIDELINES

Type of Surface Containing Spill	Recommended Cleanup Techniques	Actions to Avoid
Sand	o Use vacuum skimmer and sorbents to clean up pools of free-flowing oil.	o Do not let people or equipment travel over oiled sand.
	o Use shovels to remove and place oiled sand and tar balls into plastic bags or 55 gallon drums.	o Do not bury oiled sand.
	o Use heavy equipment where possible to clean up large areas.	o Do not remove more sand than absolutely necessary to clean up the oil.
Pebble or Gravel	o If heavily oiled, use grader and front-end loader to remove oiled gravel.	o Do not place oiled gravel or pebbles in streams, ponds, or other offshore areas.
	o If lightly oiled, use water water spray to wash oil off of gravel. Use boom to contain runoff. Recover oil with sorbent and skimmer.	o Do not bury oiled gravel.
Snow	o Use shovels to remove and place oiled snow in 55 gallon drums or lined pits.	o Do not place oiled snow on ponds or offshore ice.
		o Make sure that the storage containers do not have leaks.
Wet Tundra	Consult DEC and EPA for permits to work on tundra.	o Do not operate vehicles or heavy equipment on tundra.
	Use water flush and sorbent to clean up oil.	o Do not burn oil on tundra.

Table 4.4.2.3 (Continued)

SUMMARY
OF
SHORELINE CLEANUP GUIDELINES

Type of Surface Containing Spill	Recommended Cleanup Techniques	Actions to Avoid
Wet Tundra (Continued)	o If cleanup will cause excessive damage to tundra, request agency approval to leave oil in place.	o Avoid bird nesting areas.
Salt Marshes	o Use boom to minimize oil flow into salt marsh. o Use low pressure water flush or herd oil to areas where it can be recovered by sorbent and skimmers. o Seek agency input as to whether oil should be left in place to prevent environmental damage that could be caused by cleanup operation. o Consult agencies for advice on wildlife protection.	o Do not enter marshes with heavy equipment. o Do not block entrance to marsh with berms or dams. o Do not use dispersants or chemical agents.
Muddy Tidal Zones	o Deploy boom in water and use hose to herd oil to boom. Use skimmer to recover oil from boom. o Use shovels to remove oiled mud after the area has been flushed with water.	o Do not use heavy equipment. o Do not let people walk on oiled area. o Do not bury or cover oil on mud flat.
Water	o Use boom to prevent oil from spreading. o Use sorbent and skimmers to clean up oil.	o Avoid creating waves which may cause oil to escape boom. o Do not use dispersants or chemical agents.

4.4.2.4 Oily Debris Disposal

Oiled driftwood, vegetation, and peat can be burned in portable open-pit incinerators if permits are obtained from state and federal agencies responsible for air quality control. Incinerators which can be used for this purpose are discussed in Section 4.7.3.

Historically, landfilling has been the primary technique for disposing oiled dirt, gravel, and sand. Under current environmental regulations, it may be impossible to use this technique in Alaska. The reasons for this are: 1) there are no landfills in the state which will accept large quantities of oil contaminated material, and 2) the EPA may not grant approval for constructing landfills for oily waste disposal.

The following disposal options should be considered by the On-Scene Coordinator for oiled beach material:

- This material can be placed in leak proof containers and shipped to EPA approved landfills in the Lower-48.

- Portable fluid bed or rotary kiln incinerators can be used to remove the oil from the beach material. These units are capable of operating at temperatures which range from 1,100 to 1,800°F and will burn any hydrocarbons in the beach material. Afterwards, this material can be returned to the environment.

  The Environmental Protection Agency owns a portable rotary kiln incinerator which could be leased for cleaning oiled beach material. Esso Resources Canada in Cold Lake, Alberta, Canada, has a rotary kiln incinerator which has been used for this purpose.

4.4.2.5 Considerations for Oiled Birds

From late May through early September, thousands of birds nest along the Beaufort Sea coastline. If a major spill were to occur, it is conceivable that some of the bird population will be coated with oil.

It should be recognized that oiled bird rehabilitation programs are seldom very successful. For example, after the December 1985 oil spill at Port Angeles, Washington, 1,400 oiled birds were taken to an emergency rescue center. Newspaper and television reports stated that over 700 of these birds died and less than 40 were healthy enough to be released within a few days after being cleaned. Although more than a thousand birds were rescued, this represented only a fraction of the birds which were exposed to the spill.

Another interesting point about oiled bird rehabilitation programs is that most of the work is performed by volunteers under professional direction. Also, the rehabilitation is usually conducted in school gymnasiums or large public facilities. Whereas this concept is ideal for spills which occur near urban areas, it may not be feasible for spills in remote locations along the Beaufort Sea coastline. The reasons for this are as follows:

- Personnel would have to be transported from Anchorage, Fairbanks, or the Lower-48.
- Logistical and support requirements for volunteers working in remote arctic regions could be rather expensive.
- It may be necessary to transport oiled birds to Prudhoe Bay for rehabilitation.
- Low visibility and poor weather conditions can delay or interfere with bird rescue.
- Survival rates for rescued birds are uncertain.

With respect to who should perform bird rehabilitation, it is important to recognize that the U.S. Fish and Wildlife Service (907/452-1951) has jurisdiction over migratory waterfowl. Under current regulations, permits from this agency are required to take, possess, or transport these birds. Therefore, it would be appropriate to contact this agency prior to rescuing oiled birds. Additionally, rescue efforts should be coordinated with the Alaska Department of Fish and Game (907/464-4100).

4.4.2.6 Considerations for Oiled Marine Mammals

Seals, walrus, polar bears and other marine mammals may be coated with oil if spills occur in the Beaufort Sea. It is suggested that the On-Scene Coordinator notify the National Marine Fisheries Service (907/271-5006) and the U.S. Fish and Wildlife Service if oiled marine mammals are discovered.

Only skilled persons with appropriate training in animal handling should attempt to capture or clean marine mammals that are coated with oil. These animals can kill or inflict serious injury to humans. Additionally, these animals are likely to be under stress. Hence, improper handling could increase their mortality rate.

4.5 TRANSFER EQUIPMENT

During an oil spill cleanup operation, it will be necessary to transfer oil from: 1) a recovery device to a storage container, and 2) the storage container to a treatment or disposal center. As a result, pumps will play an important role for most offshore oil spill response operations. It is important to recognize that no pump will satisfy all oil spill transfer requirements. Additionally, the cleanup contractor should avoid using transfer pumps that will cause oil and water to form an emulsion.

This section of the Planning Guide will familiarize the On-Scene Coordinator with the pumps stockpiled by organizations in Alaska for oil spill cleanup operations. All pump specifications cited in this section are based on performance measurements using water. There may be a decrease in performance if these pumps are used to transfer viscous oils or oil-water emulsions.

4.5.1 Centrifugal Pump - Multiquip QP-20T

The Multiquip QP-20T Centrifugal Pump (trash pump) has an open impeller which enables it to handle fluids containing small debris and solids. Its maximum rated capacity and total head are 200 gpm and 90 feet, respectively. Its maximum suction lift is 25 feet. The Multiquip QP-20T Centrifugal Pump and its 4.6 hp gasoline engine are mounted on a wrap-around tubular frame. The entire unit weighs 107 pounds and can be easily moved by two persons. (This pump must be primed prior to being placed in service.)

In addition to transferring recovered oil, Centrifugal pumps are excellent for flooding shorelines with sea water to prevent oil from sticking to them. They are also useful for herding oil: 1) in marshes or on wet tundra, or 2) along coastlines to locations where it can be recovered by skimmers.

The primary advantages inherent to centrifugal pumps are as follows:

- They are small and easy to maneuver.
- They are capable of handling fluids with high concentrations of suspended solids.
- They are capable of providing a steady stream of water which may be needed to herd oil to locations where it can be easily recovered.

The disadvantages inherent to these pumps are as follows:

- They do not handle viscous fluids very well.

- They must be primed.

- They cause oil and water to form emulsions.

4.5.2 Diaphragm Pump - Multiquip QP-D302

The Multiquip QP-D302 Diaphragm Pump is a positive displacement pump which is capable of transferring fluids at rates up to 56 gpm at a maximum discharge head of 35 feet. Due to its gently pumping action, it is unlikely that this pump will cause recovered oil/water mixtures to form emulsions. It is mounted on a steel frame with a gasoline engine and be easily moved by two people.

The Multiquip QP-D302 Diaphragm Pump is ideally suited for transferring fluids recovered by weir or rope mop skimmers and unloading recovered oil from temporary storage containers. This pump has the following advantages:

- It can tolerate high concentrations of fine solids.

- It is self-priming.

- It has a low probability for causing oil/water mixtures to form emulsions.

- It can handle viscous fluids.

- It is small and easily deployed by one person.

Some of the disadvantages inherent to the Diaphragm pumps are:

- It cannot operate against a high back pressure.

- It is not suitable for herding oil slicks.

4.5.3 Destroil DS 150 Pumping System

The Destroil Pumping System contains an Archimedian screw pump powered by a hydraulic motor which is driven by a diesel engine. It is designed to handle viscous or weathered oil and oil/water emulsions. Due to its gentle pumping action the Destroil Pumping System will not emulsify oil and water mixtures. A unique feature inherent to the Destroil Pumping System is that the Archimedian screw pump can be totally submerged in the fluid which must be transferred.

The Destroil Pumping System has the following advantages:

- It can pump viscous or semi-solid materials.

- Handles small debris without problems.
- It does not emulsify oil and water.

Disadvantages inherent to the Destroil pump are as follows:

- It is not efficient for pumping light fluids, such as water, against a high back pressure.
- It is not self-priming.
- It does not have any suction lip (fluids must be placed directly into the pump).

Each of the pumps discussed in this section are available in the Alaska Clean Seas warehouse at Prudhoe Bay.

4.6 RECOVERED OIL STORAGE EQUIPMENT

Oil recovered during a cleanup operation must be stored until it can be disposed. As a result, storage is a critical link for all offshore oil spill response operations. No matter how effectively cleanup equipment can perform, it will be of little value if no provisions are made to store the oil once it is recovered.

This section of the Planning Guide will familiarize the On-Scene Coordinator with equipment which can be used to store oil recovered during cleanup operations in the Beaufort Sea.

4.6.1 Barges

Barges are frequently used to transport both fuel and equipment along the Beaufort Sea coastline. Throughout most of the year as many as 30 barges (owned by Crowley Maritime, Kodiak Oil Field Haulers, and the Prudhoe Bay Production Facilities) are located at the Prudhoe Bay west dock. These barges could be used for recovered oil storage as well as platforms for deploying portable oil spill cleanup equipment.

Many of these barges have an internal storage capacity of 6,000 barrels. Along with this, storage containers for additional capacity could be placed on the deck of each barge. These barges can be freely maneuvered through the Beaufort Sea during the open water season. During spring breakup and fall freeze-up, ice breaking vessels will be required to maneuver them through waters containing dense concentrations of broken ice. Barges cannot be moved during the winter season (mid-November to early May) due to solid ice cover in the Beaufort Sea.

Although barges are ideally suited for recovered oil storage, two limitations should be recognized. Many barges in the Beaufort Sea region have a 4 to 6 foot draft. This draft will increase when these barges are filled with oil or loaded with cargo. Consequently, they may not be able to access shallow, near shore waters with depths ranging from 1 to 6 feet. The Beaufort Sea is unique in that locations with water depths less than 6 feet can be found as far as 1 mile or more from shore.

The other limitation is that it may be difficult to off-load recovered oil stored inside of barges. Due to natural forces which impact oil spills, oil recovered during an offshore operation will likely be very viscous or emulsified. As a result, it may not be free-flowing. Although positive displacement pumps can easily pump viscous material into barges, they may not be able to off-load it. To resolve this problem, demulsifiers should be used to break emulsions prior to placing the recovered material into the barges. For very viscous oils, it may be necessary to inject steam into the barge to lower the viscosity

so that it will be free-flowing and susceptible to being off-loaded by a submersible pump such as the Destroil Pumping System.

4.6.2 Flexible Floating Containers

Plastic, nylon reinforced plastic, or rubber containers such as Dracone and Trellecone barges are suitable for the initial storage of recovered oil. These barges can store up to 50 barrels of oil and can be towed by small vessels to access cleanup operations in shallow near-shore waters. Since these barges are fabricated from heavy plastic, rubber, or nylon reinforced fabric, they can be punctured by broken ice. Therefore, they should not be used in areas that contain dense concentrations of grounded broken ice. Since they are normally pulled behind a metal vessel, it would be practical to use them in offshore conditions containing moderate concentrations of floating broken ice.

As noted in Table 4.0.1, Alaska Clean Seas has several flexible floating containers which could be used for spill response.

4.6.3 Pillow Tanks

Pillow tanks are convenient for temporary storage of recovered oil. These tanks can store up to 100 barrels of oil and are constructed from flexible materials that allow them to be compacted for easy transportation to the spill site.

Pillow tanks have two limitations. They do not float and are difficult to move once they are filled with oil. Since these tanks are constructed from heavy plastic, they are susceptible to puncture by sharp objects.

Pillow tanks can be obtained from Alaska Clean Seas' Prudhoe Bay warehouse.

4.6.4 Storage Tanks

The Prudhoe Bay Production Facility and Eskimo villages along the Alaska Beaufort Sea coastline have a number of large fuel oil storage tanks. Many of these tanks are empty during the summer season and may be available to provide temporary storage for recovered oil.

Baker Tanks provide another option for recovered oil storage. These tanks are typically used by the oil industry during well tests and many are located at Prudhoe Bay.

In some locations, 55-gallon drums may be the best alternative for storing recovered oil, oil debris, and oiled sorbents. These drums can be readily obtained from vendors in Anchorage, Alaska and the Lower-48.

4.6.5 Storage Considerations for Oiled Snow

If spills occur during the winter season, it is likely that large quantities of snow may be contaminated with oil. To avoid problems that could occur when the snow melts, oiled snow and ice should always be stored in leak-proof containers such as 55-gallon drums or lined pits. Once the snow melts, the oil can be removed with a portable skimmer or sorbents, and the water can be disposed of in accordance with procedures established by the EPA or the Alaska State Department of Conversation. According to these agencies, water which will not create a sheen can be discharged to the environment.

4.6.6 Ice Pits, Earthen Pits, Natural Depressions, and Ponds

During the winter, offshore ice pits can be constructed to provide temporary storage for recovered oil and oiled snow. In accordance with provisions set forth by the Clean Water Act, federal and state permits may be required to use ice pits as storage containers in locations which have not been affected by an oil spill.

In some situations where tanks and storage bladders are not available, it may be tempting to store recovered oil in earthen pits, natural depressions, or ponds. The On-Scene Coordinator should be aware that the Resource Conservation and Recovery Act, as well as state and federal environmental regulations, may prohibit this. Therefore, it would be prudent to obtain an opinion from the Regional Response Team prior to using earthen pits, natural depressions, or ponds to store recovered oil.

4.7 OIL SPILL DISPOSAL

Disposal may prove to be the most challenging aspect of oil response for the Beaufort Sea. This is primarily because: 1) there are no facilities in Alaska which routinely treat or recycle large quantities of waste oil, 2) state and federal regulations may prohibit landfill disposal of recovered oil and oily debris in Alaska, and 3) state and federal agencies may not allow recovered oil to be burned due to the impact that this could have on existing air quality. In view of these considerations, careful preplanning is needed to ensure that provisions will exist to dispose of recovered oil.

This section of the Planning Guide will highlight existing provisions for recovered oil disposal and suggest alternatives which may be appropriate for large spills in the Beaufort Sea region.

4.7.1 Techniques for Recovered Oil Disposal

Disposal is defined as the process of treating or storing a waste material in a manner which will render it harmless to the environment or convert it to a substance that will have commercial value. With respect to recovered oil, the following disposal techniques are available:

- In-Situ Burning/Open Burning. These entail igniting oil or oiled debris and allowing it to burn under ambient conditions. These disposal techniques are subject to restrictions and permit requirements established by federal, state, and local laws. They should not be used to burn PCBs, waste oil containing more than 1,000 ppm of halogenated solvents, or other substances regulated by the EPA.

- Recycling. This technique entails removing water, sediment, and other foreign materials from the recovered oil and blending it with uncontaminated crude oil.

- Landfill Disposal. This technique entails burying the recovered oil in approved landfills in accordance with procedures established by the EPA.

- Incineration. This technique entails the complete destruction of the recovered oil by high temperature thermal-oxidation reactions.

- Deep Well Injection. This is the process of injecting recovered oil into the earth through a disposal well which has been approved by the EPA.

Each disposal technique, except recycling, is subject to EPA regulatory requirements. These requirements, along with existing provisions for implementing these techniques, will be discussed in the following sections.

To obtain approval for in-situ/open burning, the applicant must submit a plan for the proposed open burning, addressing the eleven (11) concerns specified in the Alaska Air Quality Plan. This plan may be delivered to any office of the Department of Environmental Conservation.

Open burning in compliance with these guidelines or with written approval conditions, does not exempt any person from any civil or criminal liability for consequences or damages resulting from such burning, nor does it exempt any person from complying with any other applicable law, ordinance, regulation, rule, permit, order, or decree of this or any other governmental entity having jurisdiction. Alaska state policy regarding in-situ/open burning is provided in Appendix B.

4.7.2 In-Situ Burning

In-situ burning is defined as the process of burning an oil spill on land or water. Since the early 1970's many tests have been conducted in Alaska and Canada to evaluate the effectiveness of this technique as an oil spill countermeasure (Figure 4.7.2.1). These tests have provided the following information:

- In order for oil on water to burn, the slick must be relatively fresh and at least 3 mm thick. Since the volatile components in the oil begin to evaporate as soon as the spill occurs, the potential for in-situ burning decreases with time. Depending on wind speed and temperature, as much as 50 percent of an oil slick can evaporate in 24 hours or less. Once this occurs, it may be impossible to ignite the oil remaining on the water surface.

- Field tests suggest that up to 90 percent of an oil spill can be removed from the water surface by in-situ burning.

- Fresh oil slicks on any surface which have sufficient thickness can be ignited by matches, burning rags, air deployable igniters, and lasers.

- In-situ burning can be effective for fresh oil on snow. However, in areas with deep snow, the heat of combustion may melt a pit in the snow. Afterwards, most of the burning will occur in the pit. For example, U.S. Coast Guard tests in Alaska during 1972 showed that pits up to 1.5 feet deep and 3 feet in diameter formed while burning oil on snow. Whereas 95 percent of the oil in the pit burned, only 30 percent of the oil on the surrounding snow was consumed by combustion.

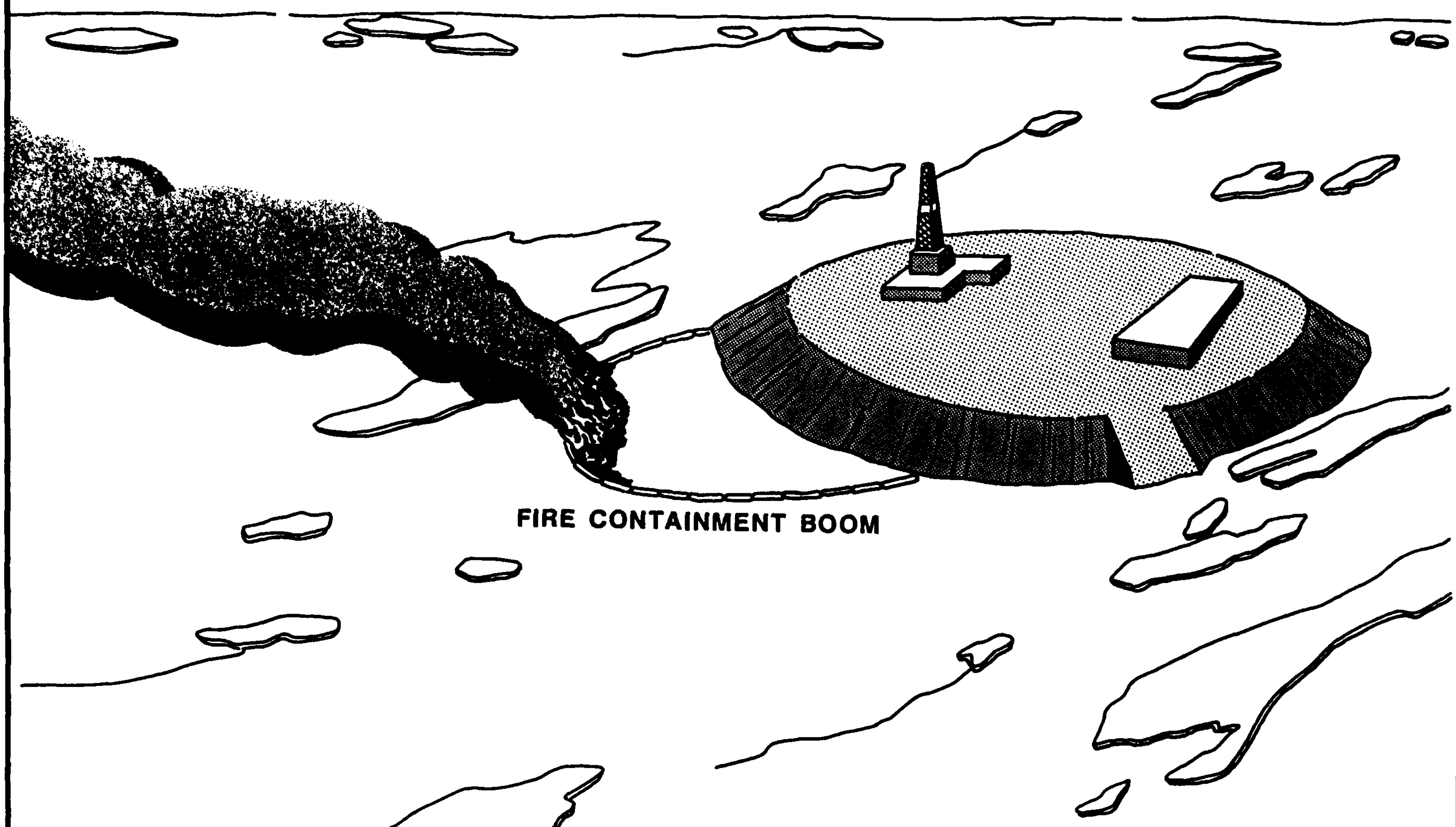


Figure 4.7.2.1 IN-SITU BURNING WITH FIRE CONTAINMENT BOOM

- In-situ burning can be effective for snow/oil mixtures. However, the maximum snow content for which combustion is possible is 70 percent for fresh Prudhoe Bay crude oil and 50 percent for fresh diesel fuel. The maximum oil removal efficiency occurs when the snow concentration is 20 percent by weight. (This quantity of water aids the combustion process.)

- In-situ burning may not be possible for weathered or emulsified oil.

- In-situ burning produces a tarry residue which could be difficult to clean up. Under optimum burn conditions, about 10 percent of the oil will remain on the water as burn residue.

- In-situ burning creates black smoke which could violate air quality control regulations and present a health hazard for nearby communities.

- In-situ burning may not be effective under wind conditions (greater than 30 knots) which will blow the flame out.

4.7.2.1 Fate and Affect of In-situ Burning

In-situ burning may not be prudent near populated areas, because it produces a variety of toxic chemicals which may adversely affect human health and welfare. For example, soot and polynuclear aromatic hydrocarbons created by in-situ burning can cause cancer and mutations in living tissue. Along with these items, the smoke from burning oil may also contain zinc, vanadium, lead, nickel, or other metals which were in the oil.

It is important to recognize that the combustion products from in-situ burning can travel great distances before falling to earth. This point is supported by observations which were made in Malmesbury and Ceres, South Africa during August 1983. On August 6, 1983, a fire broke out on the Spanish tanker "Casillo de Bellver", located 47 miles off the South African coast. Winds blew the smoke plume ashore and an oily fallout coated vegetation and livestock as far as 50 miles inland. It is important to note that surface contamination occurred 97 miles downwind of the burning oil.

The fallout resulting from in-situ burning can affect the environment in the following ways:

- Carcinogenic compounds and heavy metals in the fallout could enter both the aquatic and terrestrial food web.

- Fallout can contaminate fresh water lakes which provide drinking water for Arctic residents.

- Excessive fallout can coat plants and block the sunlight needed for photosynthesis.

- Fallout can increase the absorption of solar radiation by ice and snow. Consequently, this could contribute to early breakup in the area that is contaminated.

Acid rain can also be created by in-situ burning. If the oil contains sulfur, sulfur dioxide will be produced as the oil burns. Afterwards, it will combine with water vapor in the smoke plume and form sulfuric acid. If nitrogen oxides are produced during the burning process they will also combine with water vapor to form nitric acid. Later, as these acids fall with rain, they can adversely affect aquatic wildlife and stunt plant growth.

In view of the environmental risk associated with in-situ burning, this response technique should not be used for large spills without permits from federal, state, and local agencies responsible for air quality control. Also, personnel should not be allowed to work near burning oil without appropriate respiratory protection as recommended by a certified Industrial Hygienist or the Occupational Safety and Health Administration.

4.7.2.2 Air-Deployable Igniters

To initiate in-situ burning in remote offshore areas or ice-infested water, Alaska Clean Seas has stockpiled over 1,000 air-deployable igniters (Dome Petroleum Ltd. igniter) at its Prudhoe Bay warehouse.

As shown in Figure 4.7.2.2.1, these igniters contain a solid propellant which will ignite a spill, and enough gelled kerosene to ensure combustion for five to ten minutes. The igniters are effective for oil spills which have film thicknesses of 3 mm or greater.

A 12-volt electric igniter is required to activate this device. A 10-inch fuse provides a 45-second delay before the solid propellant ignites.

Tests in Alaska and Canada demonstrated that the Dome igniter is safe and reliable. It can be easily tossed into a slick or pool of oil from a helicopter hovering at 50 to 100 feet (Figure 4.7.2.2.2.) These igniters have a five-year shelf life and cost up to $60.00. They are manufactured by Energetex Engineering, P.O. Box 744, Suite 9, 498 Albert St. (Parkdale Plaza), Waterloo, Ontario N2J 4C2 CANADA. Phone (519) 743-7191.

4.7.2.3 Guidelines for In-Situ Burning

Since the smoke from burning oil could adversely impact the local environment, in-situ burning should never be used near populated areas or under atmospheric conditions which will cause the smoke

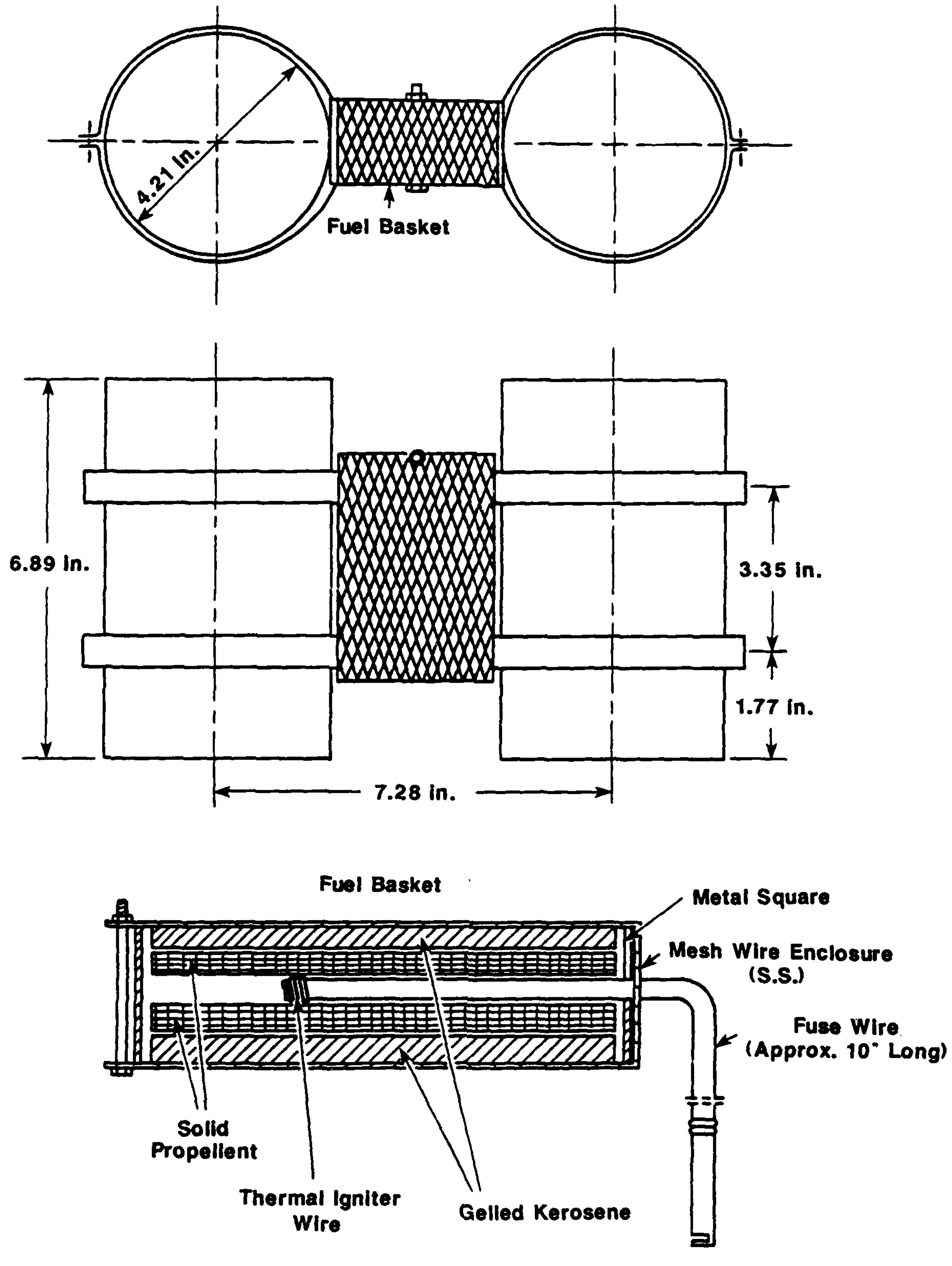


Figure 4.7.2.2.1

BASIC DESIGN AND INTERNAL COMPONENTS OF THE DOME PETROLEUM LTD. IGNITER

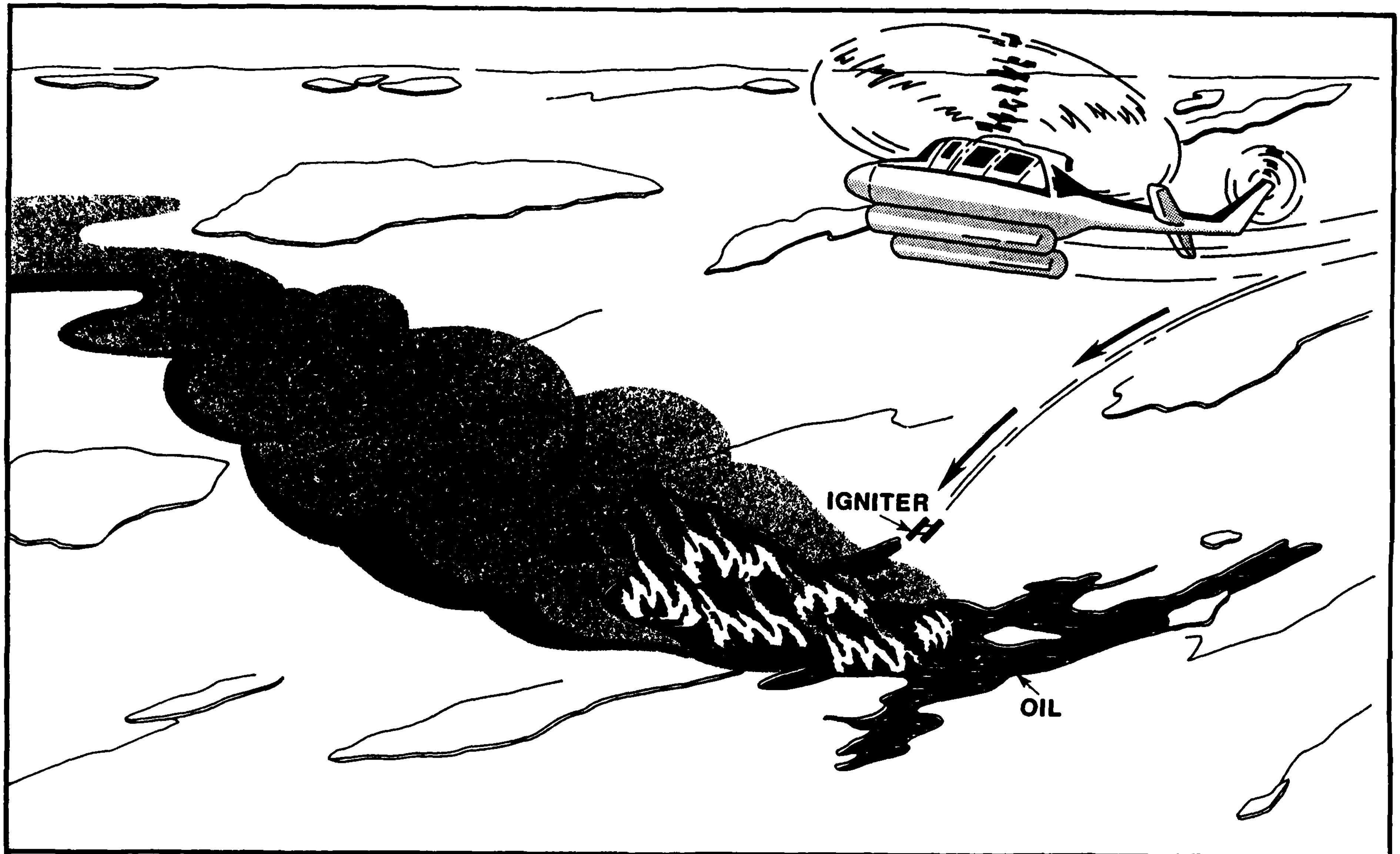


Figure 4.7.2.2.2 IN-SITU BURNING USING IGNITERS

plume to impact coastal communities. As a general rule, in-situ burning would be appropriate only when atmospheric conditions will allow the smoke to rise several hundred feet and rapidly dissipate.

Smoke from burning oil will normally rise until its temperature drops to equal the ambient temperature. Afterwards, it will travel in a horizontal direction under the influence of prevailing winds. As illustrated in Figure 4.7.2.3.1, this typically occurs in the Beaufort Sea region at elevations which range from 200 to 300 ft. Under these circumstances, it may be possible for personnel to work near the burning oil without being exposed to the products of combustion.

It is important to recognize that atmospheric inversions frequently occur in the Beaufort Sea region during the winter months. By definition, an inversion exists when atmospheric temperature increases with altitude. Normally, atmospheric temperature decreases with altitude (the higher you go, the colder it gets).

Since a cold layer of air is close to the ground during an inversion, in-situ burning would not be prudent under this condition. As shown in Figure 4.7.2.3.2, an inversion would cause the smoke to remain close to the ground and make it unsafe for personnel to work near the burning oil without respiratory protection.

As discussed in Section 4.7.2.1, the smoke created by in-situ burning may contain compounds which are hazardous to human health and detrimental to the environment. If burning occurs during an inversion, the local concentrations of these compounds may be very high.

Prior to recommending in-situ burning, the OSC should consult with the Alaska Department of Environmental Conservation (907/465-2653) and the EPA (907/271-5083) to assess the impact of the smoke plume on the environment. The OSC should also consult with the North Slope Borough (907/852-2611) to determine if it has ordinances which govern air quality control. The OSC should be aware that North Slope residents may object to large scale in-situ burning and use legal means to have it terminate. Since many North Slope residents rely on subsistence (hunting and fishing) for their nutritional needs, they may seek legal remedy for environmental damages caused by in-situ burning.

4.7.3 Open Burning

Open burning can be defined as the process of burning recovered oil and oily debris under ambient conditions. This process differs from in-situ burning in that the oil or oily debris is cleaned up and taken to a specified location for burning. This section will highlight the techniques and equipment which are available to support open burning in the Beaufort Sea region.

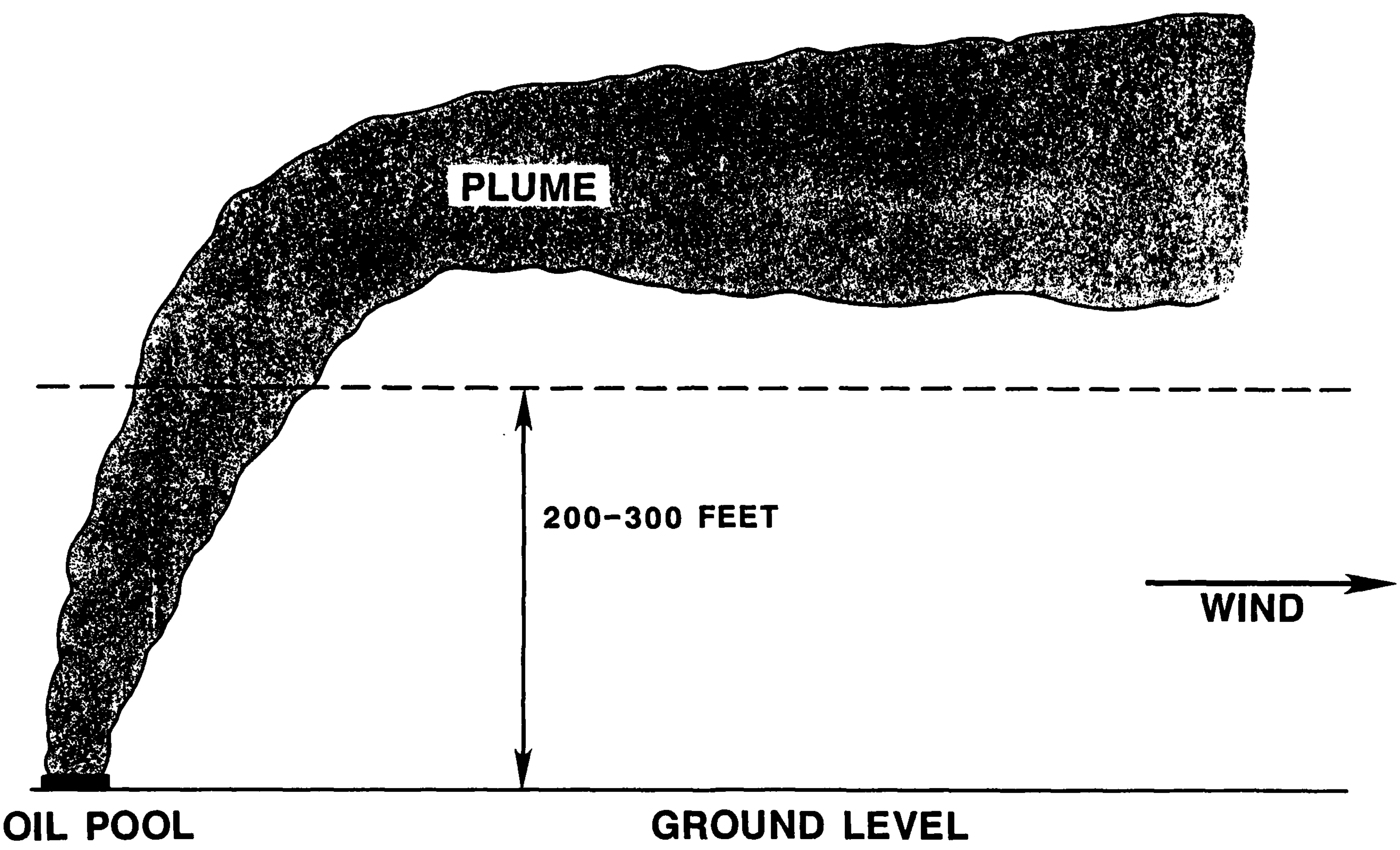


Figure 4.7.2.3.1

IN-SITU BURNING WITHOUT INVERSION

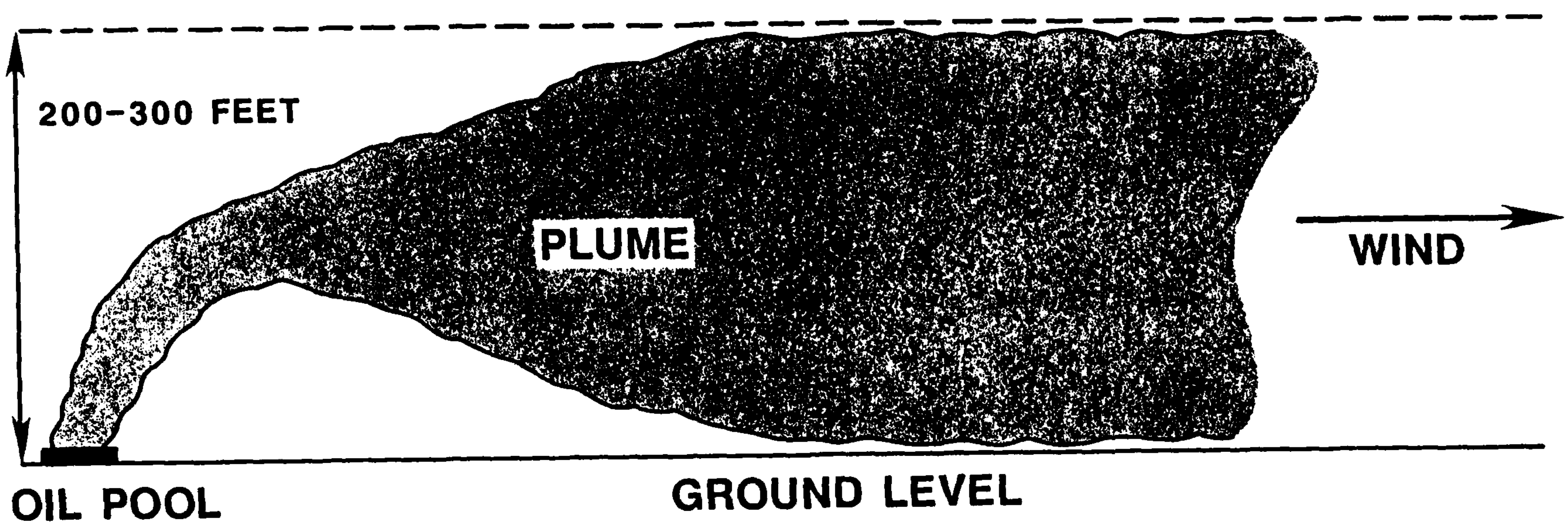


Figure 4.7.2.3.2

IN-SITU BURNING DURING AN INVERSION

4.7.3.1 Ice Pits

During the early 1980's, Alaska Clean Seas demonstrated that ice pits will provide effective containment for burning oil and snow. Ice pits were constructed by using a ditch witch to cut a 2 to 3 foot pit in near-shore ice. Afterwards, oil and oil-contaminated snow were placed in the pits and ignited. When the fire died, it was found that 90 percent of the oil had burned. About 10 percent of it remained in the pit as an oily residue which was easily removed by sorbents. Contrary to what was expected, the heat of combustion did not cause significant melting in the bottom of the pit.

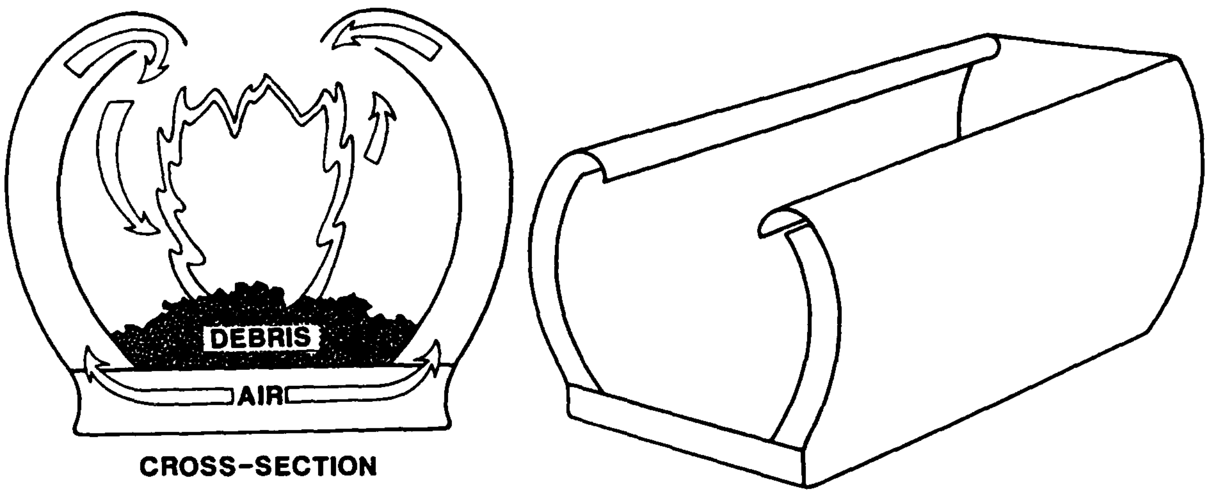
Work performed in Alaska and Canada show that ice pits are effective for burning recovered oil during the winter season (November through April). These pits should not be constructed in areas where the ice is not thick (4 ft. or less) enough to support heavy equipment. The reason for this is that dump trucks and front-end loaders may be required to transport recovered oil and snow to the pits for combustion. Additionally, the ice must be thick enough to support the equipment for constructing the pit. After the burning is completed, care should be exercised to ensure that all residual oil is removed from the pit.

4.7.3.2 Air Portable Incinerator

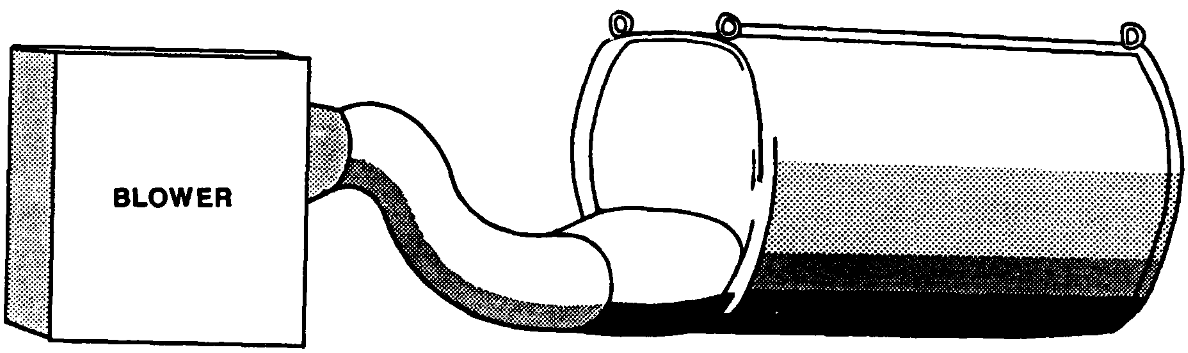
During 1984, Alaska Clean Seas (ACS) obtained an Air Transportable Incinerator. As shown in Figure 4.7.3.2, this unit consists of a double-walled stainless steel combustion chamber and a diesel-driven blower. Both sections weigh 1,873 pounds and they can be assembled in approximately 10 minutes.

During field tests in Canada, a similar incinerator was able to burn up to 0.9 tons of heavily-oiled sorbents per hour with smoke emissions that ranged from Ringleman No. 1 to Ringleman No. 2. (The Ringleman Number defines the amount of light passing through a smoke plume. For Numbers 1 and 2, the amount of light passing through a smoke plume is 80% and 60%, respectively.) Throughout these tests, the outer wall of the combustion chamber remained at ambient temperature. The reason for this is that insulation is provided by the air (7,000 CFM @ 60°F) which travels through the void space between the combustion chamber's walls (Figure 4.7.3.2.) This air also provides excess oxygen which supports the combustion process and is responsible for low smoke emissions.

ACS field tested its Air Transportable Incinerator at Prudhoe Bay during December 1984. This test included a 40-gallon mixture of waste oil and solvents and 440 gallons of residue created by in-situ burning. The average feed rate was 485 pounds per hour and about 99 percent of this material was consumed by combustion. During this test, high temperatures damaged sections of the combustion chamber which does not have double walls.



SCHEMATIC DIAGRAM OF INCINERATOR DESIGN



ASSEMBLED INCINERATOR WITH DIESEL POWERED BLOWER AT LEFT

Figure 4.7.3.2	**AIR TRANSPORTABLE INCINERATOR**

The primary disadvantage inherent to this incinerator is that it does not have any provisions for continuously feeding liquids. Prior to start-up, oiled debris can be placed in the combustion chamber through its door. Once this unit is in service, additional material is added by tossing it over the wall on the upwind side of the combustion chamber.

The Air Transportable Incinerator is currently stored in ACS's Anchorage warehouse and can be transported by truck or aircraft to Prudhoe Bay. From there it can be transported to remote areas by helicopter. This incinerator can be used during any season to dispose of oil and any form of oiled debris that will burn. Where practical, it should be used in preference to in-situ or open burning.

4.7.3.3 Trecan Incinerator

The U.S. Coast Guard's Trecan Incinerator is currently stored at ACS' Anchorage warehouse. As shown in Figure 4.7.3.3, this unit includes a blower and a combustion chamber. This chamber consists of several L-shaped sections of fire-brick, each weighing about 900 pounds. The dimensions for the combustion chamber are 11.8 ft by 6.9 ft by 6.6 ft.

The Trecan Incinerator was designed to be transported by helicopter and burn up to 1 ton of oiled debris per hour without creating large quantities of black smoke. Due to the weight of each section, a crane is required to position them for assembly. Since 1/8" to 1/4" spaces may exist between the floor sections, the Trecan Incinerator is not suitable for burning liquids or oiled snow and ice.

4.7.3.4 Flare Burners

Flare burners can be used to dispose of large quantities of oil and emulsions recovered during offshore cleanup operations. During February 1977, the Atlantic Richfield Company (ARCO) tested the Noralco Dual Burner Flare (NDBF) at Prudhoe Bay. The objective of this test was to determine if this unit could rapidly burn large quantities of crude oil, diesel fuel, and tank bottoms without creating smoke. This unit performed well throughout the tests. It was able to burn up to 540 Bbls of feed per hour without producing any smoke.

The NDBF is currently stored at the Noralco warehouse (907-561-1669) in Anchorage, Alaska. It can be transported to Prudhoe Bay by truck or Hercules aircraft. Setup and ancillary equipment for this unit are shown in Figures 4.7.3.4. Noralco will provide personnel to operate this unit.

The U.S. Coast Guard flare burner is stored at the ACS warehouse in Anchorage, Alaska. This unit is designed to burn up to 10,000 Bbls of oil per hour. It can be transported by truck or Hercules aircraft. Additionally, it can be mounted on a barge and operat-

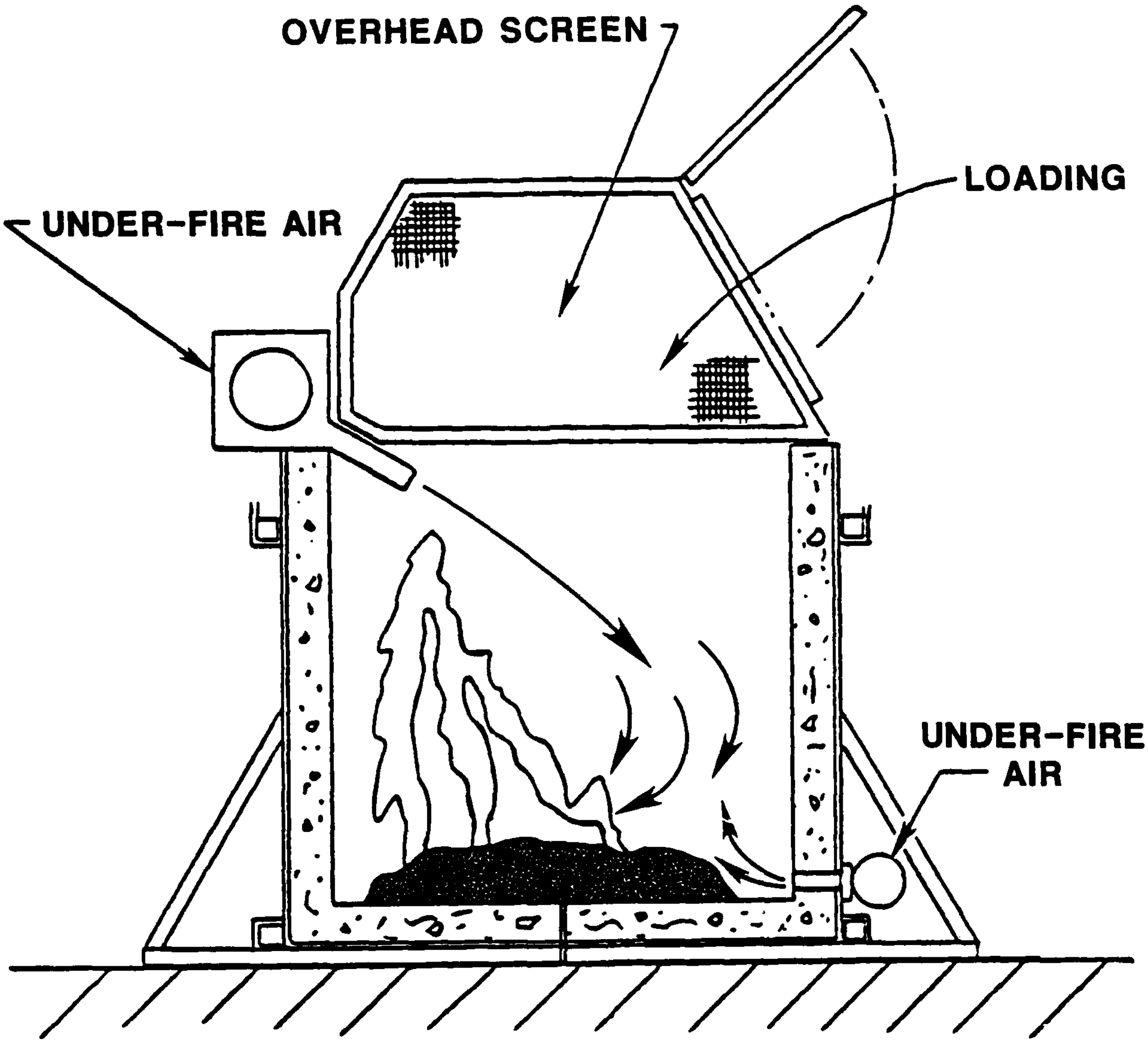


Figure 4.7.3.3	TRECAN INCINERATOR

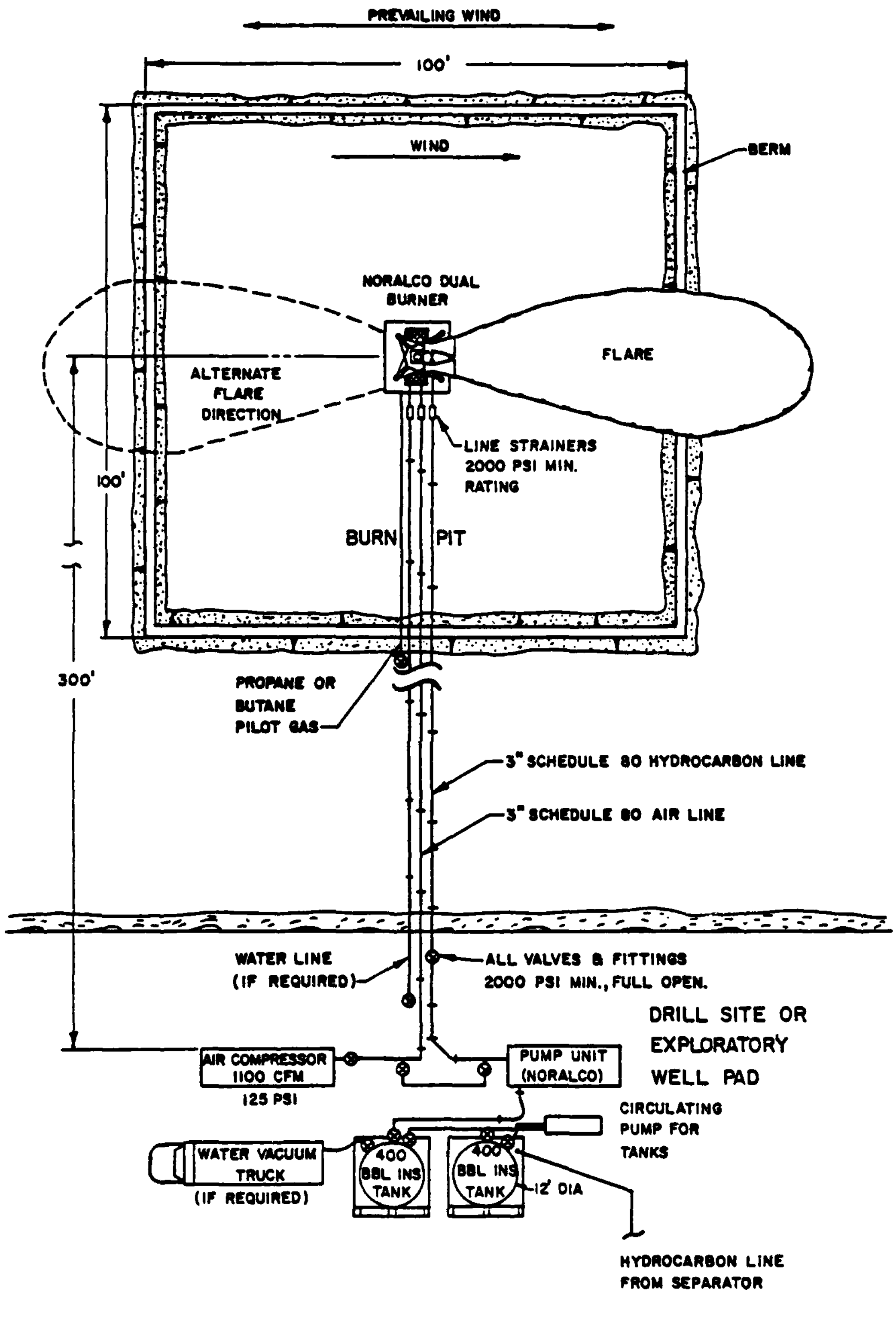


Figure 4.7.3.4

NORALCO BURNER AND SUPPORT EQUIPMENT

ed offshore. Neither the Coast Guard nor ACS has published test results which show how well this unit performs in an arctic environment. Also, sufficient personnel with adequate training for operating it may not be available.

4.7.4 Recycling

Although it is possible to recycle recovered oil, several problems may prevent this from being a reality for oil spills in the Beaufort Sea. Currently, there are no facilities in Alaska which routinely recycle petroleum products. Since the recovered oil may be emulsified with sea water and contain suspended solids, quality control specifications may prohibit it from being injected into the Alaska Pipeline. Depending on the price of oil, it may not be cost effective to recycle the recovered product at facilities in the Lower-48.

4.7.5 Landfill Disposal

On May 8, 1985, the Environmental Protection Agency (EPA) banned the disposal of free liquids in landfills. Presently, there are no landfills in Alaska that will accept recovered oil for on-site disposal. If a spill were to occur, it is unlikely that regulatory agencies would issue permits for constructing a landfill.

Some companies in the Lower-48 will solidify recovered oil so that it can meet EPA criteria for landfill disposal. However, this procedure may be far more costly than disposal by burning or recycling. In summary, disposal in landfills is not an attractive option for recovered oil.

4.7.6 Deep Well Injection

ARCO has an injection well at its Prudhoe Bay facility. However, during August 1985, ARCO lost its permit to operate this well. Since the owner is responsible for all materials pumped into its injection well, it is conceivable that ARCO may not allow this well to be used for recovered oil disposal even if the appropriate permits were obtained. Under the Resource Conservation and Recovery Act, the EPA plans to ban deep well injection of many items, a list of which has not been prepared. Hence, this alternative may not be available for recovered oil disposal in Alaska.

4.7.7 Incineration

The North Slope Borough operates a municipal incinerator at Prudhoe Bay. This unit is suitable for disposing recovered oil and oily debris which will not generate temperatures in excess of 1700°F. Arrangements for using this disposal option can be made by contacting the North Slope Borough Mayor at 907/852-2611. Minor modifications may be required to feed recovered oil to this incinerator.

4.8 PERSONNEL

Personnel are the most important aspect of any oil spill response operation. For spills in the Beaufort Sea, it is important to know where to obtain personnel who are capable of implementing cleanup activities in Arctic conditions. It is also important to know how to clothe, shelter, and feed personnel responding to spills in remote locations. These considerations will be addressed in this section of the Planning Guide.

4.8.1 Industry Oil Spill Response Teams

All oil spill response operations will require trained personnel for field supervision, equipment deployment, and logistical support. To satisfy this requirement, companies conducting oil and gas activities in the Beaufort Sea have established response teams to ensure that personnel are available for oil spill response planning and supervision. An organization chart for a typical industry response team is shown in Figure 4.8.1.

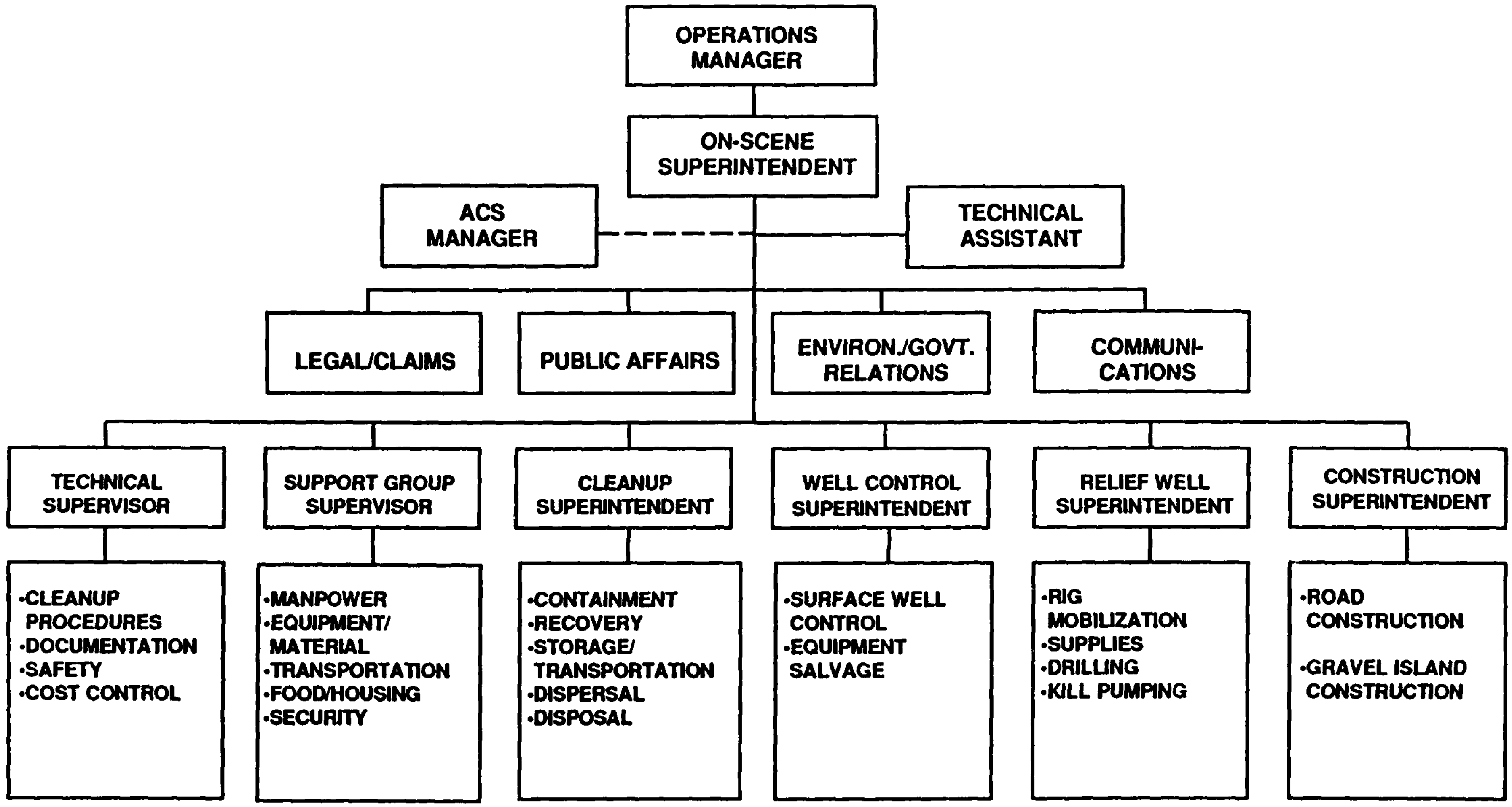
Persons filling response team positions usually attend one or more of the training courses provided by Alaska Clean Seas and participate in training exercises mandated by state and federal agencies. Technical training for well control activities is usually provided by each Operator.

In accordance with state and federal permits for exploration and development activities in the Beaufort Sea, the Operator must activate his response team and other personnel as required to contain and clean up spills which result from his facility.

For mystery spills, it would be appropriate for the On-Scene Coordinator to determine if and under what conditions Beaufort Sea Operators would allow their personnel to participate in the cleanup activity. Since oil spills could negatively impact the permitting process for future oil and gas activities in the Beaufort Sea, it is conceivable that the Operators would provide some assistance for responding to spills which did not result from their facilities.

4.8.2 Oil Spill Cleanup Contractors

For development and exploratory drilling in the Beaufort Sea, minor oil spills which result from day-to-day operations would be cleaned up by the on-site drilling crew under supervision provided by the Operator's response team. However, the Operator would likely use Cleanup Contractors for oil spills which require: 1) offshore response, 2) shoreline cleanup and protection, and 3) equipment mobilization from the ABSORB warehouse or other locations.



NOTE: POSITION TITLES MAY VARY FOR SOME COMPANIES

Figure 4.8.1

INDUSTRY OIL SPILL RESPONSE TEAM

Currently, there are three Oil Spill Cleanup Contractors in Alaska: 1) AJIT Shah, Inc. (907/344-2625), 2) Alaska Offshore, Inc. (907/349-4578), and 3) Crowley Environmental Services Corp. (907/344-1511). Each contractor is capable of providing equipment and personnel for oil spill cleanup operations. It is estimated that together they can provide up to 24 experienced personnel within 6 to 12 hours of notification. They can also network with Lower-48 affiliates to provide additional experienced personnel within 12 to 48 hours.

For some situations, Oil Spill Cleanup Contractors in Alaska are likely to be the only ones with sufficient hands-on experience for effectively implementing oil spill countermeasures in the Beaufort Sea region. Along with this, they are familiar with the arctic environment and the limitations that it can present. Another advantage is that they will work under adverse conditions.

For small spills which can be recovered in a few days, it is conceivable that the Oil Spill Cleanup Contractors can provide sufficient personnel. For larger spills, it would be advisable to obtain additional personnel from local labor pools and allow them to be trained and supervised by the Oil Spill Cleanup Contractors. Under this scenario, it would be appropriate to form a number of five-man cleanup crews. Each crew should be staffed with one person provided by a Cleanup Contractor and four persons obtained from a labor pool or North Slope Oil Field Support Company, such as Frontier, GSL, or VECO. A suggested list of equipment which should be provided for each response crew is provided in Table 4.8.2.

Due to the climate in the Beaufort Sea region and the degree of physical effort which may be required during an oil spill cleanup operation, it is unlikely that the response crews will be capable of working more than 6 to 8 hours per day. Therefore, three crews per task may be needed for a 24-hour operation. Between shifts, shelter can be provided at field camps or hotels at Deadhorse, Alaska (Prudhoe Bay).

Since personnel from Anchorage or the Lower-48 may not be accustomed to working in an arctic environment, steps should be taken to guard against frostbite and dehydration.

4.8.3 Oil Spill Consultants

Oil Spill Consultants (907/248-5980) and Spiltec (907/346-1932) are Alaskan firms which specialize in providing technical support for oil spill response planning and cleanup operations. Both firms are familiar with the resources which are available for responding to spills in the Beaufort Sea. As a result, they can provide valuable input which may help the On-Scene Coordinator establish priorities and implement a response operation. They

can also organize response operations and provide supervision for Oil Spill Cleanup Contractors.

4.8.4 Alaska Clean Seas

Alaska Clean Seas (ACS) is an industry-sponsored oil spill co-op for Alaska. Contrary to what some believe, ACS is not an oil spill response organization. It was established by the oil industry to store and maintain oil spill cleanup equipment, conduct oil spill R&D, and provide oil spill response training for industry personnel.

As a general rule, ACS will provide a Captain and tanker-person for its self-propelled recovery vessel "ARCAT Skimmer". It will not provide personnel for mobilizing or deploying other items in its equipment inventory. It is incumbent upon the spiller or Coast Guard to provide personnel for this purpose.

4.8.5 Clothing, Shelter, and Food

Oil Spill Cleanup Contractors and Consultants have the appropriate clothing for working in arctic conditions. In most cases, this will not be true for contract labor and personnel from Anchorage, Fairbanks, or the Lower-48. Therefore, if personnel from these locations are mobilized for spill response, it will be necessary for the OSC to ensure that arctic clothing is provided. A list of the items which should be provided for each person is shown in Table 4.8.5. These items can be purchased at stores in Fairbanks and Anchorage which sell arctic clothing and rainwear.

Shelter can be provided by hotels and construction camps at Deadhorse, Alaska. Most of these facilities have dining halls which can provide meals that can be consumed on location or transported to remote locations. The ABSORB 40-person base camp is also located at Deadhorse and has facilities for preparing meals. This camp can be transported to other locations in the Beaufort Sea region by Hercules aircraft.

Several hotels are located in Barrow, Alaska. Although they can provide shelter, they do not have cafeterias or restaurants. Both Barrow and Deadhorse have good airports. Therefore, they are good locations for oil spill response base camps. From here, personnel can be transported to the cleanup site by helicopter.

After establishing a base camp at locations such as Deadhorse, Barrow, or Barter Island, field camps should be set up near the cleanup site. To accomplish this, large portable shelters can be obtained from the ABSORB warehouse. The objective for the field camp is to provide heated resting and eating areas for the cleanup crew. Although portable shelters can be used for temporary living quarters, all personnel should be evacuated to base camps when storms are forecasted.

Each field camp should have a designated kitchen area which contains at least 5 gallons of portable water per day for each person and a 5-day supply of food for each person (canned and freeze-dried). It should also include a portable stove for heating water and warming food. To avoid problems with polar bears and foxes, all opened food containers should be placed in metal trash cans located several hundred feet from the field camp.

The field camps should be equipped with two-way radios and portable heaters suitable for indoor use. Each camp should have one or more portable toilets and provisions for washing hands. During the winter months, portable light stands and electrical generators will be needed. These items can be obtained from the ABSORB warehouse.

Fuel for the generators and fire extinguishers should also be in each camp. Additionally, the camps should contain a tool kit, first-aid kit, and a rifle (most foxes on the North Slope carry rabies).

4.8.6 Personnel Safety

Prolonged exposure to oil vapors can cause headaches, dizziness, nausea, vomiting, and abdominal pains. Additionally, prolonged contact with oil can cause skin irritation. Therefore, to minimize exposure, respiratory protection and protective clothing should be provided for personnel to crude oil, diesel fuel, jet fuel, or gasoline spills.

To minimize the potential for fire and explosions, smoking should only be allowed in predesignated areas that do not contain spilled or recovered oil.

Table 4.8.2

RESPONSE EQUIPMENT
FOR
FIVE-PERSON CREW

Purpose	Equipment	Quantity
CONTAINMENT	Boom	1,000 Ft.
	Boom Anchors	25
CLEANUP	Rope Mop Skimmer	1
	Weir Skimmer	1
	Sorbent	500 lbm
	Shovel	5
	Pitch Fork	5
TRANSFER	Centrifugal Pump	1
	Positive Displacement Pump	1
STORAGE	55-Gallon Drums with Tops	10
	Drum Pallets	2
	Heavy Duty Plastic Bags	100
COMMUNICATION	Portable Two-Way Radio	3
SUPPORT EQUIPMENT	Generators	1
	Lights	1 Set
	Rubber Gloves	20 Pair
	Boats	1
	Tool Kits	1
	Tents	1
	Heaters	1
	Water	25 Gallons
	Flashlights	5
	Dry Food	10 lbm
	Portable Toilet	1
	Toilet Paper	5 rolls
	Blankets	5
SAFETY	Survival Suits	5
	Life Vests	5
	Rope	200 Ft.
	Rifle (1)	1
	First Aid Kit	1
	Respirators (Organic Vapor, & H_2S Filters)	5

Notes: 1. To scare away bears and rabid animals.

Table 4.8.5

CLOTHING AND ARCTIC GEAR
FOR BEAUFORT SEA OIL SPILL
RESPONSE OPERATION

Items Per Person	Quantity
Rain Suit	1 set
Hip boots	1 pair
Coveralls	1 pair
Rubber Gloves	2 sets
Parka	1 each
Arctic Trousers	1 each
Arctic Pac Boots w/liner	1 pair
Wool Socks	3 pair
Thermal underwear	2 pair
Work Gloves	2 pair
Duffel Bag	1 each
Sunglasses	1 pair
Utility Knife	1 each

4.9 LOGISTICS

4.9.1 General

Rapid response during the initial stage of an oil spill is the best approach for minimizing the magnitude of a cleanup operation and protecting sensitive areas. To accomplish this, plans and provisions must be available to transport personnel and equipment to the spill site and support the response operation. Although an abundance of logistical resources are available in the Beaufort Sea region, environmental conditions could prevent rapid deployment. For example, broken ice, dense fog, or whiteouts may temporarily restrict access to the spill site. Additionally, wet tundra, shallow water, and mud flats could limit shoreline response countermeasures.

This section of the Planning Guide will familiarize the On-Scene Coordinator (OSC) with the logistical resources which are available at Prudhoe Bay, Alaska. It will also show how and under what conditions these resources can be used to support oil spill response activities in the Beaufort Sea.

Figure 4.9.1 provides distance contours for the Beaufort Sea and travel speeds for various modes of transportation. This information can be used by the OCS to assess how long it will take to reach spill locations in the Beaufort Sea. Table 4.9.1 identifies sources for equipment and logistical support at Prudhoe Bay.

4.9.2 Seasonal Considerations

4.9.2.1 Freeze-up

During the initial stages of ice formation (freeze-up) in the Beaufort Sea, helicopters will be the primary means for transporting equipment and personnel to offshore locations. Normally, all offshore drilling structures have a helicopter landing pad. A summary of helicopter capability is provided in Table 4.9.2.1. Both ERA Aviation (907/659-2465) and Evergreen Helicopters have a fleet of helicopters and fixed wing aircraft at Prudhoe Bay. Figure 4.9.2.1 summarizes seasonal constraints for Beaufort Sea logistics.

In ice thicknesses greater than one foot, marine transportation is limited to ice-breaking tugs and barges. Crowley Maritime (907/349-8551) has an ice-breaking barge (Arctic Endeavor) at Prudhoe Bay which is capable of breaking solid ice cover up to 1.8 feet thick. Ice-strengthened tugs and barges can also be obtained from Kodiak Oilfield Haulers at (907/349-2648) or GSL at (907/659-2646).

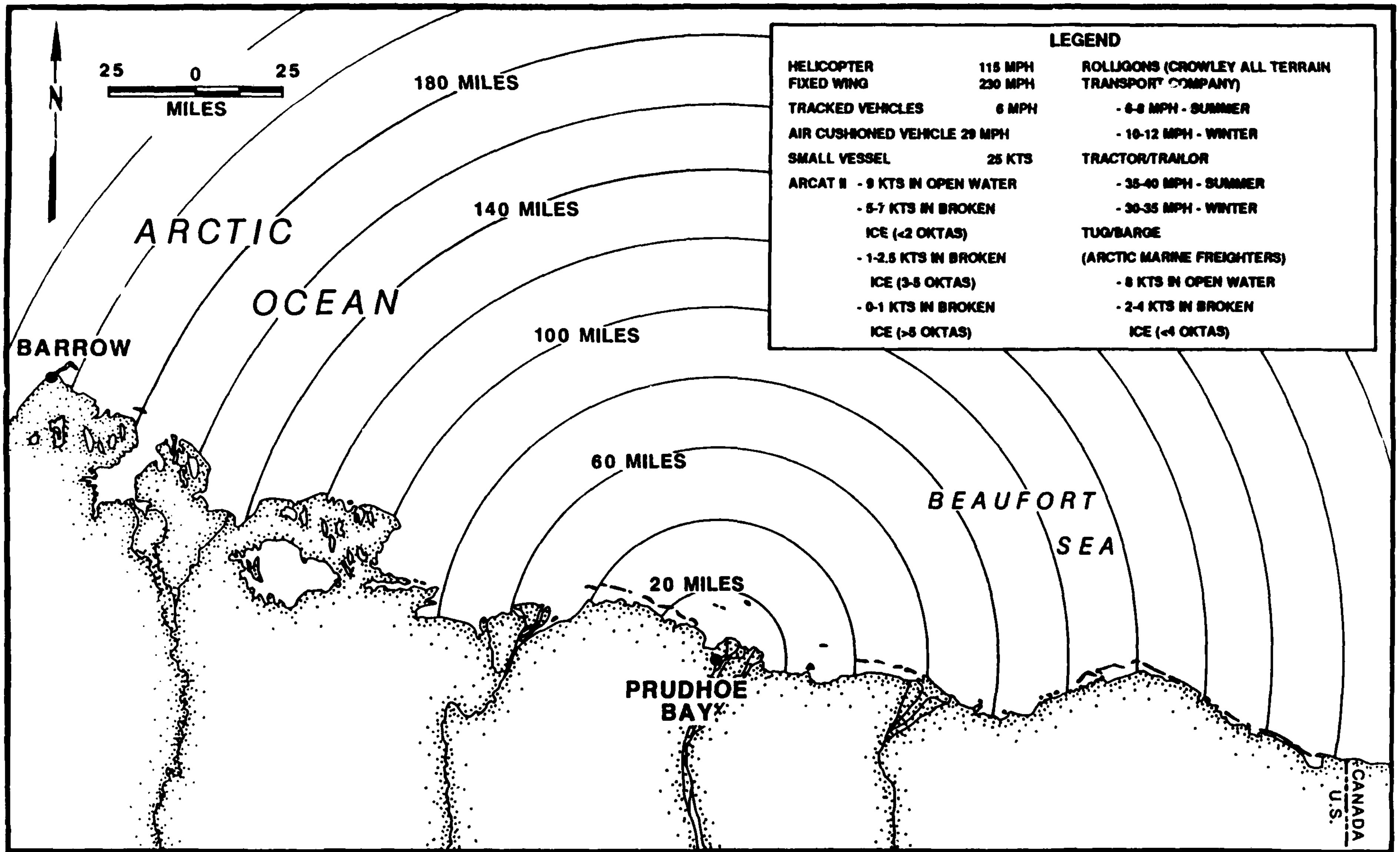


Figure 4.9.1

DISTANCE CONTOURS FROM PRUDHOE BAY
THE BEAUFORT SEA REGION

Table 4.9.1

NORTH SLOPE SUPPLIES & SERVICES

The following equipment and supplies are available at the Prudhoe Bay industrial complex and can be obtained for oil spill response operations:

1.	Helicopter and Air Transportation		
	A. ERA	Telephone	659-2465
	B. Evergreen Helicopters of Alaska	Telephone	659-2457
	C. Sea Airmotive	Telephone	659-2634
2.	Trucks, Tank Trucks, Vacuum Trucks, Rolligons.		
	A. Mukluk Freight Lines	Telephone	659-2686
	B. Kodiak Oilfield Haulers	Telephone	659-2648
	C. CATCO	Telephone	659-2414
3.	Heavy Equipment - Dozers, Fork Lifts, Scrapers, Dump Trucks, Front End Loaders		
	A. Frontier Rock and Sand	Telephone	659-2565
	B. Kodiak Oilfield Haulers	Telephone	659-2648
	C. Alaska General Const. Co.	Telephone	659-2445
	D. Alaska International Constructors	Telephone	659-2598
4.	ABSORB Warehouse oil spill response equipment:	Telephone	659-2405
	Manager - Robert M. Johnson	Telephone	345-3142
		Home Phone	345-5440
5.	Contract Labor		
	A. GSL Oilfield Services	Telephone	659-2646
	B. Pioneer Oilfield Services	Telephone	659-2565
	C. VECO	Telephone	659-2533
6.	Petroleum Industry Equipment.		
	A. Standard	Telephone	659-3101
	B. ARCO	Telephone	659-3106
7.	Mud and Weight Materials		
	A. BAROID - through Frontier Rock & Sand, or;	Telephone	659-2565
	Anchorage	Telephone	272-7571
	B. Dresser Magcobar	Telephone	659-2694
8.	High Pressure Pumps, Cement, and Bulk Handling Equipment		
	A. Dowell	Telephone	659-2434
	B. Halliburton	Telephone	659-2805

Table 4.9.2.1

HELICOPTER CAPABILITY

	Boeing Vertol 107	Sikorsky S-61	Bell 206 L	Bell 212	Super Puma AS-332L
Seating[1]	24 (P) 4 (C)	19 (P) 2 (C)	6 (P) 1 (C)	14 (P) 2 (C)	18 (P) 2 (C)
Maximum Gross Weight (Pounds)	22,000	20,500	4,000	11,200	18,400
Fuel Capacity (Gallons)	500	600	98	220	960
Average Fuel Consumption (Gallons/Hour)	107-180	170	33	105	147
Maximum Range (Miles)	345	437	330	213	786
Cruise Speed (Miles/Hour)	138	132	125	115	155
Useful Load (Full Fuel) (Pounds)	9,000	8,000	776	3,051	8,390
Maximum Flight Time (Hours) based on Fuel Capacity	2.78	3.53	2.97	2.10	6.53
Operating time (Hours) at Spill Site after Flying 100 Miles	1.30	2.00	1.40	.27	5.23

[1] (P) Passengers
(C) Crew

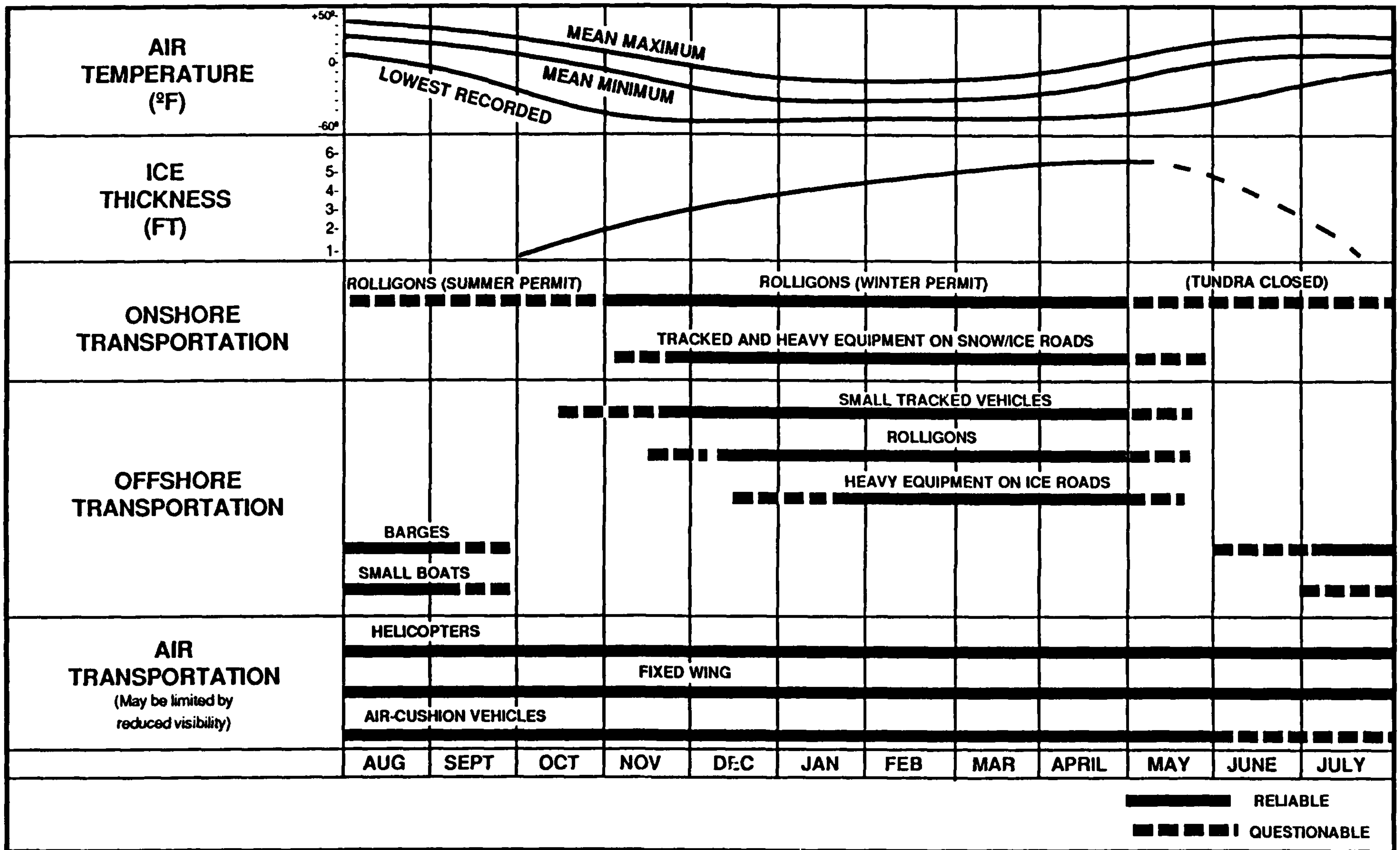


Figure 4.9.2.1

SEASONAL CONSTRAINTS FOR BEAUFORT SEA LOGISTICS

Helicopters, rolligons, or ACVs can be used to transport personnel and equipment across tundra or access shoreline areas which can not be reached by marine vessels.

4.9.2.2 Winter

During winter, logistical support for oil spill response activities can be provided by aircraft and ground transportation. For offshore locations, trucks and heavy equipment should be restricted to ice thicknesses greater than 3.5 feet to maximize safety. Rolligons can be used on ice with thicknesses greater than 2 feet. Unless authorization is granted by the On-Scene Coordinator, no vehicles should be allowed on ice with thicknesses less than 2 feet.

Trucks, rolligons, and heavy equipment should not be allowed to travel across tundra unless permits are obtained from the Alaska Department of Natural Resources (907/479-2243)

4.9.2.3 Breakup

During the initial stage of breakup (solid ice covered with water), helicopters will be the primary means for supporting oil spill response operations. When the ice cover breaks (100% broken ice or less), ice-strengthened and conventional barges pushed by tugs can be used. Both Crowley Maritime and Kodiak Oilfield Haulers have ice-strengthened barges and tugs at Prudhoe Bay.

Along with transporting response equipment, barges can be used as: 1) work platforms for deploying cleanup equipment, 2) platforms for work camps, 3) containers for storing recovered oil, and 4) platforms for operating flare burners for recovered cil disposal. For cleanup operations that will span several seasons, barges can remain at the spill site during the winter and be used as a work platform during the following breakup.

Throughout breakup, air cushion vehicles (ACV's) can move equipment and personnel to offshore locations. Helicopters can be used to tow ACV's that are not self-propelled. ACV's can also be used as work platforms for operating portable cleanup equipment during breakup.

4.9.2.4 Open Water

Boats, barges, and aircraft are the primary modes of offshore transportation during the open water season. Alaska Clean Seas' ARCAT Skimmer and North Star workboat are available for logistical support. The speeds for these vessels are approximately 8 knots and 12 knots, respectively. Under optimum weather conditions and seas less than 3 feet, the ARCAT Skimmer can travel approximately 110 miles in 12 hours. The North Star can travel about 165 miles in this time frame. The North Star can be

transported to remote locations by helicopter or C-130 Hercules aircraft.

Rolligons, helicopters, small boats, and shallow draft barges can be used to access shoreline areas where cleanup is required. Prior to using land vehicles to cross tundra, permits from state and/or federal agencies are required. CATCO (907/659-2414) has a tundra permit with summer restrictions. Seasonal Constraints for Beaufort Sea Logistics are summarized in Figure 4.9.2.1.

4.9.3 Modes of Transportation

4.9.3.1 Aircraft

Aircraft are essential for most industrial operations in the Prudhoe Bay/Beaufort Sea region. As a result, many helicopters and fixed wing aircraft are permanently stationed at Prudhoe Bay. These aircraft can be used to provide logistical support for oil spill response activities. Large aircraft, such as the (C-130), L-100-30 Hercules cargo plane can be obtained from MarkAir (907/266-6224) in Anchorage, Alaska (see Appendix F).

Based on information provided by ERA Aviation, aircraft operating in the Prudhoe Bay region are capable of using either visual flight rules (VFR) or instrument flight rules (IFR). For example, aircraft can use VFR if the ceiling or distance to the first cloud layer is at least 1,000 ft. and horizontal visibility is three miles or more. During reduced visibility, aircraft can operate under IFR if the visibility is equal to or greater than ½ mile. These rules must be followed by aircraft operating within a 5-mile radius of the Deadhorse airport. However, in other areas in the Beaufort Sea region, pilot discretion will be the primary factor for determining if aircraft can safely operate.

Normally helicopters can operate in wind speeds in excess of 50 knots. The decision to operate aircraft under existing wind conditions will be made on a case-by-case basis by the aviation contractor.

Time requirements for transporting response equipment from other locations in Alaska to Prudhoe Bay are identified in Table 4.9.3.1. This table also identifies the timing required to obtain response equipment from co-ops in California.

4.9.3.1.1 North Slope Airports and Runways

Air transportation will play a key role during response operations for major spills in the Beaufort Sea. The following sections provide a brief summary of airports and runways in this region. The Alaskan Beaufort Sea Coastal Resources Manual published by Alaska Clean Seas includes a series of maps which identify landing strips near the Beaufort Sea Coastline.

Runway lengths for other North Slope Borough villages and industrial sites are identified in Table 4.9.3.1.1 and Figure 4.9.3.1.1.

Table 4.9.3.1

TIME REQUIRED TO OBTAIN EQUIPMENT FROM OTHER AREAS

Equipment Source	Storage Location	Mobilization Time hr	Travel (1) Time To Prudhoe Bay hrs	Travel (2) Time To Spill Location hrs	Deployment (4) Time hrs	Total (5) Estimated Response Time hrs
ABSORB	Prudhoe Bay, AK	1-2	-	2-3 (3)	2	5 - 7
Ciro	Kenai, AK	2-5	3	1	2	8 - 11
Alyeska	Prudhoe Bay, AK	1-2	-	2-3 (3)	2	5 - 7
USCG	Anchorage, AK	2-5	3.5	1	2	8.5 - 11.5
USCG	Kodiak, AK	2-5	4.5	1	2	9.5 - 12.5
USCG	San Francisco, CA	2-5	13	1	2	18 - 21
Clean Sound Inc.	Seattle, WA	2-5	9	1	2	14 - 17
Clean Bay, Inc.	Concord, CA	2-5	13	1	2	18 - 21
Clean Seas Inc.	Santa Barbara, CA	2-5	15	1	2	20 - 23
Clean Coastal Waters (CCW)	Long Beach, CA	2-5	16	1	2	21 - 24

Notes:
1. Based on C-130 Hercules Aircraft at 280 Mile/Hr.
2. Landing Point at Lonely (5,000 ft. Gravel Runway) Approximately 160 Miles From Deadhorse.
3. Helicopter Flying Time (60 - 80 Mile/Hr) to Staging Area Near Lonely
4. Estimated time required to begin containment and cleanup assuming equipment deployed from Lonely.
5. This is the minimum estimated response time. Actual time may increase depending on weather conditions.

Table 4.9.3.1.1

NORTH SLOPE RUNWAYS

Village	Runway Length Ft.	Surface	Distance From Barrow (Miles)
Anaktuvuk Pass	5,000	Gravel	248
Atqasuk	1,100	Dirt with steel landing mats	49
Barrow	6,500	Asphalt	-
Kaktovik	5,000	Gravel	340
Kuparuk	6,000	Gravel	170
Prudhoe Bay	6,499	Asphalt	210
Nuiqsut	5,000	Gravel	132
Point Hope	4,100	Gravel	282
Point Lay	3,519	Gravel	158
Kuparuk	6,000	Asphalt	170
Wainwright	2,200	Gravel	72

Source: Alaska Regional Profile

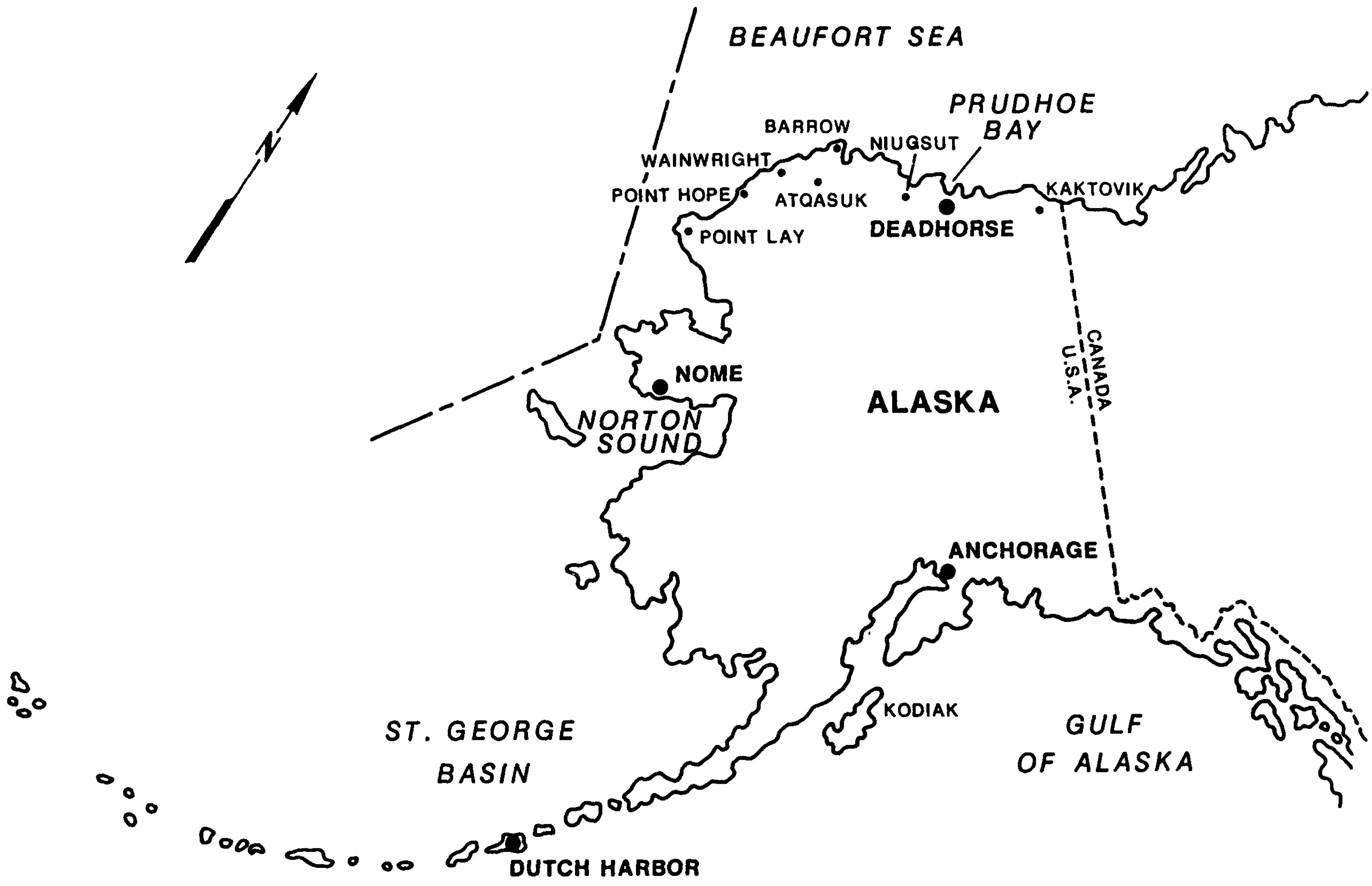


Figure 4.9.3.1.1 LOCATION OF NORTH SLOPE RUNWAYS

Anaktuvuk Pass

Anaktuvuk Pass (Figure 4.9.3.1.1) has a 5,000 ft. runway which is equipped with lights and a non-directional radio beacon. This runway is capable of handling a fully loaded (48,000 pounds gross freight) C-130 Hercules aircraft.

Atqasuk

Atqasuk has three airstrips which can be used by light aircraft. A 1,100 ft. by 50 ft. airstrip is located north of the village. It is aligned on an east-west axis and partially covered with steel landing mats to facilitate safe landing during wet weather. This airstrip is used by light aircraft which routinely service Atqasuk and would be recommended for use during local oil spill response activities.

A 1,200 ft. by 50 ft. airstrip is located along the eastern edge of Atqasuk. It is aligned crossways to prevailing winds and can be very muddy during wet weather. A short airstrip is located approximately 1.5 miles south of the village. However, the access road leading to it is usually in poor condition during the summer months.

Barrow

The Barrow airport has a 6,500 ft. by 150 ft. asphalt runway. It is also equipped with a non-directional beacon, a medium intensity lighting system, visual approach slope indicator, instrument landing system, directional finder, and a combined high frequency omni-directional radio range and tactical nation system.

A FAA Flight Service Station and a Weather Service Station are located at the Barrow airport. The State of Alaska maintains equipment at the airport for responding to fire or emergency aircraft landings. The State also maintains and operates snow removal equipment for the airport. The Barrow Volunteer Fire Department provides backup support for fire fighting. Except for periods of heavy fog or whiteouts, the Barrow airport is open.

The Barrow airport is serviced daily by major airlines and is capable of handling large aircraft loaded with heavy cargo. In addition to serving Barrow, it serves as the transportation hub for Atqasuk, Nuiqsut, Wainwright, and Point Lay.

Kaktovik

Air transportation to Kaktovik is possible via an Air Force airport facility located on Barter Island. This facility has a 5,000 ft. by 150 ft. gravel runway which is capable of handling a

fully loaded C-130 Hercules aircraft. This facility is also equipped with a lighting system for the runway and a non-directional beacon. Air Force permission is required to use the runway.

Kuparuk

ARCO Alaska Inc. has a 6,000 ft. by 130 ft. gravel runway at its Kuparuk Production Facility. This runway has approach lights and a wind indicator. Although this is a private runway, it would be opened for oil spill response operations.

Nuiqsut

Nuiqsut has a 5,000 ft. by 150 ft. gravel runway which is equipped with lights and a rotating beacon. This runway is capable of handling a C-130 Hercules aircraft loaded with 48,000 pounds of cargo. In addition to the runway, it is possible for aircraft loaded with heavy cargo to land on the Nechelik Channel when sufficient ice thickness exists.

Point Hope

The Point Hope airport has a 4,100 ft. by 100 ft. gravel airstrip which is capable of handling a loaded C-130 Hercules aircraft. It is equipped with an airstrip lighting system and a non-directional beacon. The lighting system can be activated by aircraft using a radio key.

Point Lay

The Air Force maintains a 3,519 ft. by 100 ft. gravel airstrip near Point Lay. It is equipped with a lighting system and a non-directional beacon. Maximum aircraft cargo capacity is limited to 27,000 pounds for this airstrip. Air Force permission is required for civilian use of this airstrip.

When sufficient ice thickness exists, aircraft landing strips can be constructed on Kasegaluk Lagoon. This alternative could be used to accommodate a loaded C-130 Hercules aircraft.

Prudhoe Bay (Deadhorse, Alaska)

Prudhoe Bay has a 6,499 ft. by 50 ft. asphalt runway. This is owned by the State of Alaska and equipped with high intensity runway lights.

Wainwright

Wainwright has a 2,200 ft. by 100 ft. gravel airstrip. Due to its length, it cannot handle large aircraft fully loaded with cargo. During the winter season, landing strips can be

constructed on the sea ice near the village to accommodate loaded C-130 Hercules aircraft.

4.9.3.2 Air Cushion Vehicles

A 100-ton air cushion vehicle (ACV), jointly owned by Global Marine Development and VECO is located at Prudhoe Bay. During June of 1982, Sohio demonstrated that this ACV can transport 50 tons of cargo over water containing high concentrations of broken ice. During a 50-mile trip it was towed by a Boeing/Kawasaki Vertol 107 helicopter against a 30-knot head wind. The helicopter was able to tow the ACV at speeds up to 10 knots.

In terms of limitations, all weather conditions that would restrict utilization of helicopters would prevent mobilizing this ACV. The helicopter which towed the ACV during the Sohio demonstration is owned by Alaska Helicopters Incorporated. Currently, they own two Vertol 107's which are permanently stationed in Anchorage. Depending upon wind speed, the average transit time for these helicopters from Anchorage to Prudhoe Bay would be approximately six hours. Therefore, 12 to 24 hours would be required to deploy the ACV by helicopter.

4.9.3.3 Barges and Tugs

There are about 32 barges stationed at Prudhoe Bay. Four are jointly owned by ARCO, Exxon, and Sohio. Five are owned by Kodiak Marine Transportation and 23 are owned by Crowley Maritime Corporation. Most of the barges at Prudhoe Bay are capable of operating in water containing up to 80% broken ice.

Reduced visibility will not present problems for tugs and barges in the Beaufort Sea due to radar and other navigation equipment that would be used. These vessels can also operate in wind speeds up to 40 knots.

Crowley Maritime has several tugs that can operate in seas up to 20 feet. In terms of ice cover, there are several ice-breaking tugs available at Prudhoe Bay. For example, Kodiak Maritime Transportation has two ABS Class A tugs that can effectively navigate in broken ice concentrations in excess of 80% and break through solid ice covers up to 12 inches thick. Additionally, Crowley Maritime has an ice breaking barge (Arctic Endeavor) located at Prudhoe Bay. This barge is pushed by two 2,100 horsepower tugs and can maneuver through dense concentrations of broken ice floes up to 3.8 feet thick. Also, it can break through solid ice 1.8 feet thick.

4.9.3.4 Ground Transportation

4.9.3.4.1 Rolligons

Rolligons play a valuable role in Arctic exploration. They are designed to operate on swamps, ice, and tundra. As a result, they are permitted to travel on the tundra year round. However, to minimize tundra damage, rolligons should always travel over different paths and carry, on the average, only 10,000 to 15,000 pounds of cargo. During the winter months when the tundra is frozen, rolligons can carry up to 60,000 pounds of cargo.

4.9.3.4.2 Ice Roads

Ice roads are used to minimize tundra damage during the winter as well as to allow surface transportation over frozen waters. These roads are built by spraying fresh water over the existing surface. The ideal temperature for ice road construction is -10°F or less, which generally exists by mid-November. Ice roads must be one to three feet thick when built over frozen tundra and a minimum of five feet thick when built over rivers, lakes, or ponds. A five foot thick ice road will support a 125 to 175 ton tractor-trailer load. Ice roads can also be used as landing strips for fixed wing aircrafts. Under these circumstances, the ice road should be at least 2,500 feet in length, 150 feet wide and have a minimum ice thickness of 3.5 feet for light aircraft.

4.9.4 Oil Spill Response Equipment

Most of the oil spill cleanup equipment owned by co-ops and industry in the Beaufort Sea region is stored on pallets. In some cases, the pallets have the equipment name and weight listed on them. A forklift will be required to place the pallets on vessels so that they can be transported to the spill site. In addition to booms and skimmers, Alyeska's and Alaska Clean Seas' Prudhoe Bay warehouses have a variety of pumps, electric generators, hoses, and 55-gallon drums stored on pallets (See Table 4.0.1).

Helicopters or other aircraft for transporting containment or recovery equipment can be obtained by contacting ERA Aviation (907/659-2465) or Evergreen Helicopters (907/659-2457). The On-Scene Coordinator or his representative should work with ERA or Evergreen to determine which helicopters are best suited for specific operations. The primary criteria for determining which helicopter to use should be based on payload and operating range. Helicopters should be equipped with appropriate instrumentation for navigating during periods of reduced visibility, i.e. dense fog, darkness, and blowing snow.

Ground transportation for personnel can be obtained from Veco Inc. (907/659-2533), GSL (907/659-2646), Frontier Equipment Co. (907/659-2565), or ARCTIC Rentals (907/659-2699).

Financial arrangements or purchase orders may be required to obtain industry or contractor equipment for spill response.

4.9.5 Communication

Alaska Clean Seas (ACS) has a portable communication system at its ABSORB warehouse (Deadhorse, Alaska). This system contains a communications network, sleeping quarters, and diesel powered generators. Additionally, ACS has a Federal Communications Commission (FCC) license for this system.

As shown in Figure 4.9.5, the communications network includes a base station and portable UHF, VHF, and SSB radios which operate on the following frequencies:

- UHF 1 - 454.00 MHz and 459.00 MHz. These frequencies have been allocated by the FCC for oil spill response operations. ACS uses these frequencies for communications at the spill site.
- VHF 1 - 158.445 MHz and 159.480MHz. These frequencies have also been allocated by the FCC for oil spill response operations. ACS uses these frequencies for logistic support.
- VHF 2 - 152.42 MHz. This frequency is used by many facilities at Prudhoe Bay. It is designated by ACS as a back-up frequency for logistics and personnel support.
- Marine VHF - 156.8 MHz, 156.6 MHz, and 156.45 MHz. These frequencies are used to communicate with marine vessels.
- Air to Ground VHF - 122.8f5 MHz. This frequency is used by an aeronautical multicom radio to communicate with aircraft.

The ACS communications network also includes UHF Dial Radio Telephones (DRT) and a high frequency single-sideband radio. The DRT transmit to a 200-ft tower at Deadhorse, then via wire lines to the Deadhorse telephone switchboard. The single-sideband radio provides secondary communications with land stations. It can operate on Alaska Public Fixed Frequencies and allow direct communication from the command module to Fairbanks, Alaska or Anchorage, Alaska.

The communications system is housed in two portable trailers (8 ft. by 16 ft. each). One contains the communications equipment while the other one contains the power generator (6KW-110V) and fuel supply (10 days' supply). Both trailers can be transported by helicopter or rolligon.

Under the ACS charter, the ACS communications system can be leased by any party responding to oil spills in the Beaufort Sea region. However, the user is responsible for operating it.

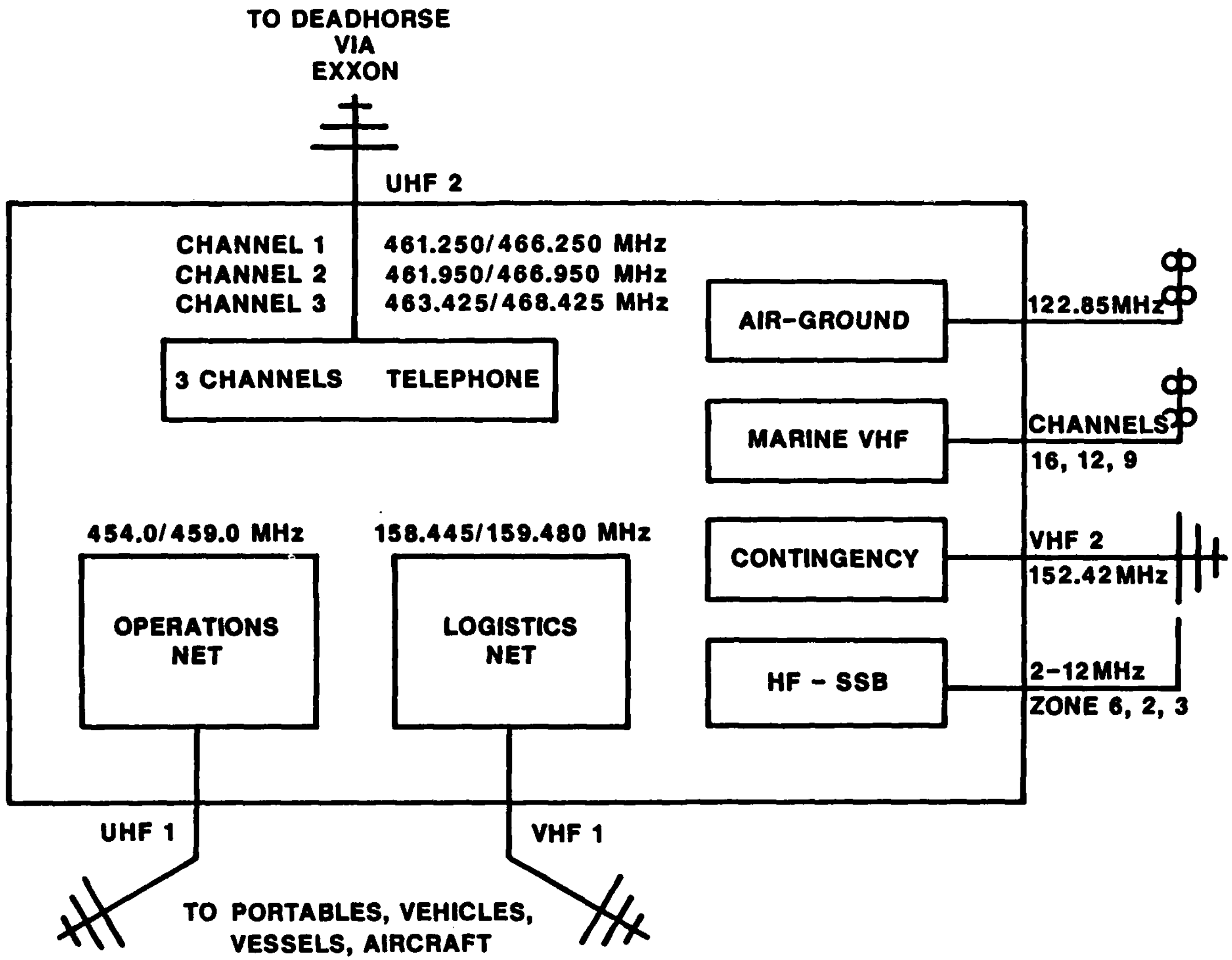


Figure 4.9.5

ACS COMMUNICATIONS SYSTEM AT THE ABSORB WAREHOUSE

4.10 WELL CONTROL

Subsurface formations which contain hydrocarbons (oil and gas) are normally under thousands of pounds of pressure. If these formations are punctured, the pressure will force the hydrocarbons to the surface and create a blowout, i.e., an uncontrolled release of hydrocarbons from the well to the environment. In view of this, the petroleum industry has developed techniques which allow oil wells to be drilled while controlling formation pressure.

The development of well control techniques was heavily influenced by the 1901 Lucus gusher near Beaumont, Texas. Almost immediately after the Operator set casing at 880 ft., a blowout occurred releasing 50,000 barrels of oil per day for nine days. Prior to this, most Operators had never envisioned that blowouts were possible.

Today, blowouts are the most feared event associated with drilling activity in the Beaufort Sea. The reasons for this are: 1) existing environmental conditions may prevent timely implementation of blowout termination techniques, 2) blowouts can cause large oil spills which could adversely affect marine wildlife and sensitive shorelines and 3) existing oil spill cleanup technology may not be adequate for large spills in ice-infested water.

4.10.1 Well Control Requirements

In accordance with federal regulations (30 CFR 250), the Minerals Management Service has established Outer Continental Shelf (OCS) Orders which govern oil and gas activities in federal waters. These orders set strict requirements which are designed to minimize the potential for well control problems and blowouts. For example, they require the operator to develop:

- Well control programs which include blowout control equipment.
- Casing and drilling mud programs.
- Oil Spill prevention and control programs.
- Relief well plans.

These and other requirements set by the OCS Orders must be satisfied before the Minerals Management Service will issue a

permit to drill. The State of Alaska has adopted similar provisions to ensure that adequate steps are taken for well control in state waters.

4.10.2 Well Control Equipment

Each well must have a program which identifies the depths at which casing (steel pipe) will be placed in the well. Casing plays a vital role in the well control program because it prevents formation fluids from entering the well. It also prevents the walls of the well from caving in.

When the well is about 300 ft. deep, surface casing is set and cemented in place. Afterwards, a blowout preventer (BOP) is mounted on top of the surface casing. The BOP includes several valves which automatically close if abnormal down-hole pressures develop. After these valves are closed, the BOP will prevent formation fluids from escaping the well.

For most drilling operations, drilling mud (a mixture of clay and water or refined oil) is used to control formation pressure in the well. For example, if this pressure is 5,000 pounds per square inch, the Operator may circulate drilling mud through the well at pressures which are somewhat higher. Since the Operator's pressure is greater, it prevents formation fluids from entering the well.

4.10.3 Reasons for Blowouts

In order for a blowout to occur, a formation containing hydrocarbons must be penetrated during the drilling operation and the well must be open. Since all drilling operations have a BOP which is capable of closing the well, it is reasonable to conclude that most blowouts are caused by equipment failure or human error. In some circumstances, both events can contribute to a blowout. For instance, during February 1984, problems developed on a well off the east coast of Canada and the operator delayed implementing emergency procedures for well control. When these procedures were implemented, mechanical failures occurred. Consequently, a blowout resulted.

It should also be recognized that acts of nature can also cause blowouts. This was demonstrated in 1976 when ice forced a Canadian drillship off location and broke the riser stem below its blowout preventer. (The BOP for drillships and other floating drilling structures is located on the sea floor.)

4.10.4 Blowout Statistics

From 1955 to 1980, there were 162 blowouts in the Gulf of Mexico. As shown in Table 4.10.4, only 12 of these blowouts created oil

Table 4.10.4

OFFSHORE BLOWOUT STATISTICS

	1955 - 1980 (1)	1971 - 1982 (2)
Number of Wells Drilled	36,633	3,385
Number of Blowouts	162	25
Number of Blowouts that Discharged Oil	12	0
Blowouts Experiencing Fire and Explosion	30%	N/A
Kill Mechanism		
- Bridging	35%	76%
- Surface Techniques	58%	8%
- Relief Wells	7%	16%
Average Blowout Duration	N/A	3.3 Days

Ref: 1. Canada Oil and Gas Lands Administration, "Relief Well Drilling Capability on Canada Lands", 1985

2. U.S. Geological Survey Open-File Report 80-101 and Open-File Report 83-562

spills. It is interesting to note that surface techniques were used to stop 58 percent of these blowouts. By comparison, 35 percent and 7 percent were stopped by well bridging (plugging by sand) and relief wells, respectively.

During the early 1970's, the Minerals Management Service (MMS) began to compile blowout statistics for the U.S. Outer Continental Shelf. Their records from 1971 to 1982 (Table 4.10.4) show that 25 blowouts occurred during this period. None of these blowouts created oil spills. Although MMS data shows that the average blowout duration was 3.3 days, it is important to understand that the blowouts which required relief wells lasted much longer. In some cases, they lasted more than 30 days.

4.10.5 Blowout Termination

4.10.5.1 Surface Techniques

As discussed in Section 4.10.2, exploration wells on gravel islands or other bottom-founded drilling structures have surface casing and a BOP which can be accessed by well control experts. If a blowout occurs and these items remain in place, it is likely that surface techniques can be used to shut in the well (terminate or kill the blowout).

Boots and Coots (713/931-8884), Red Adair (713/464-0230) and Wild Well Control (713/353-5481) are companies which have successfully used surface techniques to stop blowouts. In some cases, this entailed manually activating the BOP or placing a cap over the surface casing. In situations where the well was burning, explosives were used to extinguish the fire. When the explosives were detonated, the resulting force caused a temporary vacuum at the well. Therefore, without air to support combustion, the fire died.

It may be impossible to use surface techniques if the blowout ejects the casing from the well. Additionally, these techniques may not be possible for blowouts on ice islands which have experienced significant melting or blowouts created by floating drilling structures, i.e., drillships.

4.10.5.2 Relief Wells

If surface techniques are not possible or effective, relief wells may be required to stop a blowout. However, with respect to the Beaufort Sea, this is much easier said than done. The reasons for this are:

- Since very few relief wells have been used to stop offshore blowouts, sufficient expertise may not be available to immediately implement this technique in the Beaufort Sea.

- In water depths less than 50 ft., a gravel island would have to be constructed for a relief well. Estimated timing for this is provided in Table 4.10.5.2.1. A summary relief well capability for the Beaufort Sea is provided in Figure 4.10.5.2.

- Since drillships do not normally carry extra BOP's or anchors, backup equipment would have to be mobilized from Canada to begin a relief well. If heavy ice conditions exist, this may not be possible until the following summer. (Due to Beaufort Sea ice conditions, the operating season for drillships is from mid-July through late October. About 60 days are required to drill a 12,000 ft. well from a drillship.)

In view of these considerations, it is unlikely that a relief well will provide an immediate solution for stopping a blowout. It is also conceivable that more than one relief well may be required. For example, two relief wells were drilled to stop the 1979 Ixtoc I blowout in the Gulf of Mexico. One of the wells required 6 months to complete. The other one took 8 months. After the final relief well was completed, about 45 days were required to kill the blowout. This was accomplished by pumping mud, neoprene balls, lead balls and iron shot into it. A summary of significant blowouts and response activities is provided in Table 4.10.5.2.2.

4.10.6 Well Ignition

Since the first Beaufort Sea Oil and Gas Lease Sale in 1979, well ignition has been considered as the primary technique for minimizing the amount of oil released by a blowout. Although data is not available, industry and agency personnel speculate that 75 to 95 percent of the oil from a blowout on land or a gravel island would be consumed by combustion if the well was ignited.

The objective of well ignition is to reduce the impact that an oil spill could have on land and water. However, the products of combustion created by a burning well will create air pollution and possibly violate ambient air quality standards established by the Federal Clean Air Act. Also, if the oil contains sulfur compounds, the well ignition may contribute to acid rain formation.

As part of the well ignition decision, the following questions should be considered:

- Which would have the greater impact on human health and the environment, oil on the water surface or air pollution from burning oil?

- Is burning necessary to eliminate an explosion hazard so that surface well control techniques can be implemented?

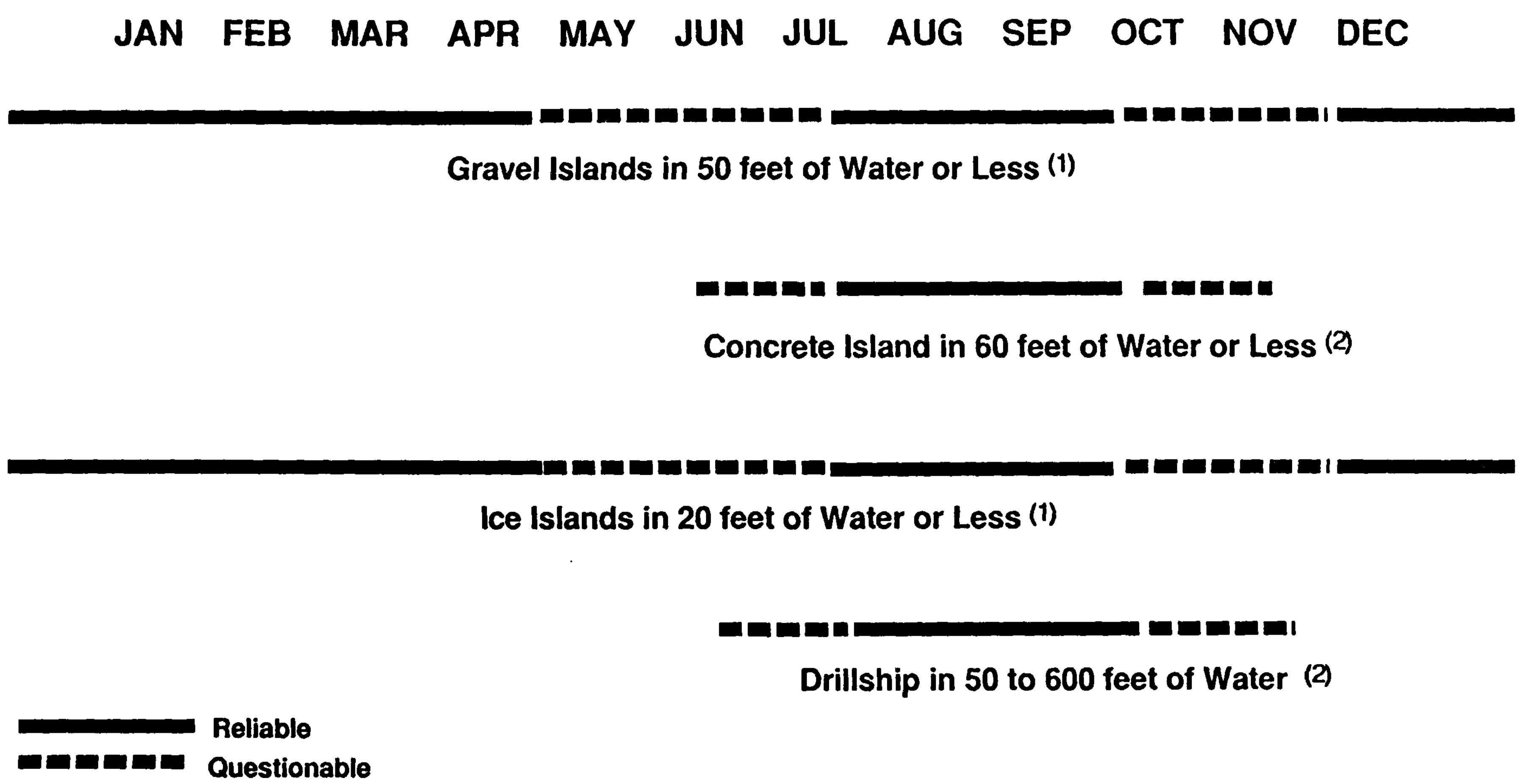
Table 4.10.5.2.1

RELIEF WELL TIMING FOR
BEAUFORT SEA BLOWOUTS[1]

ITEM	WINTER BLOWOUT	BREAKUP BLOWOUT	OPEN WATER BLOWOUT
Blowout Date	Jan. 1	June 1	Aug. 1
Island Completion[2]	Apr. 15 (105 days)	Sept. 30 (122 days)	Oct. 15 (76 days)
Mobilize Rig	Apr. 25 (10 days)	Oct. 10 (10 days)	Oct. 25 (10 days)
Drill and Complete	May 25 (30 days)	Nov. 9 (30 days)	Nov. 24 (30 days)
Kill Well Operation	June 1 (7 days)	Nov. 16 (7 days)	Dec. 1 (7 days)
Blow Duration	5 Months (152 days)	5.6 Months (169 days)	4.1 Months (123 days)

Note: 1. These scenarios are for gravel islands. Actual timing may be longer depending on ice and weather conditions.

2. Gravel islands would be used in water depths less than 50 to 60 ft. For deeper waters, drillships would be the primary structure for relief wells. If ice conditions permit, relief well timing would be much less than for gravel islands.



Notes:
(1) Relief well can not be drilled until Gravel Island is constructed. For shallow water ($\geq$ 6 ft.), rig can be mounted on barge for relief well.
(2) Drillship supported by ice breaker for relief well.

Figure 4.10.5.2

RELIEF WELL CAPABILITY FOR BEAUFORT SEA DRILLING STRUCTURES

Table 4.10.5.2.2

SUMMARY OF SIGNIFICANT BLOWOUTS

Date	Location	Type of Blowout	Drilling Structure	Blowout Cause	Blowout Duration	Blowout Kill Procedure	Max Release Rate BOPD	Oil Spilled Bbls.	Oil Recovered
May 1985	Cook Inlet (Alaska)	Surface	Platform (Grayling)	Mechanical Failure	6 Days	None (Well Bridged)	-	-	Only Gas and Water Released
February 1984	Canadian Atlantic	Surface	Platform Uniack G-72	Human Error and Mechanical Failure	10 Days	Pumped Heavy Mud	300	1,600	No Attempt
June 1979	Gulf of Mexico	Sub-Sea	Platform SEDCO 135 Ixtoc I	Mechanical Failure and Human Error	9 Months	Two Relief Wells	30,000	3,333,333	105,000 Bbls
July 1978	Canadian Beaufort Sea	Sub-Sea	Drillship Kaglulik A-75 Well	Human Error and Moving Ice	14 Days	Capped Well	-	-	Only Gas and Water Released
April 1977	North Sea	Surface	Platform Ekofisk Bravo	Mechanical Failure	7.5 Days	Capped Well	20,700	155,250	5,500 Bbls
January 1977	Canadian Beaufort Sea	Sub-Sea	Drillship Koponar	Mechanical Failure	-	Relief Well	-	-	Only Gas and Water Released
1976	Canadian Beaufort Sea	Sub-Sea	Drillship Tingmiark K-91 Well	Mechanical Failure	2 Years	None	-	-	Only Gas and Water Released
1976	Canadian Beaufort Sea	Sub-Sea	Drillship Kopanoar D-14 Well	Mechanical Failure	1-2 Years	None	-	-	Only Gas and Water Released
January 1969	Santa Barbara	Sub-Sea	Platform Well No. 21	Act of Nature	4 Months	Pumped Oil From Reservoir	600	80,000	No Estimate

Well ignition decision is complex and will require input from government agencies, the Operator, and OSC. Although there are environmental trade-offs, well ignition can reduce the amount of oil entering the water from a surface blowout. On the other hand, it may not be effective for subsea blowouts. Although the gas released by subsea blowouts will burn once it reaches the atmosphere, emulsification and thin oil films may prevent the oil from burning.

4.10.7 Blowout Responsibility

Due to existing state and federal permit requirements for offshore petroleum activity, it is unlikely that the On-Scene Coordinator (OSC) would be responsible for well control activities. As outlined by existing permit requirements, the Operator is required to assume responsibility for and carry out all activities necessary for well control. However, it would be prudent for the OSC to consider the following points:

- o Request the Operations Manager to identify who has the authority to make key decisions for the response operation. This is important because personnel in the Anchorage office may not have the authority to commit to some well control activities. Instead, these decisions may be made by personnel at their headquarters located in other areas of the country.
- o Encourage the Operator to develop a critical path for well control and spill minimization. The critical path should identify timing for: 1) the well ignition decision, 2) equipment mobilization/relief well implementation, and 3) oil spill containment and cleanup.
- o If the Operator is not able to simultaneously conduct well control activities and implement oil spill countermeasures, it may be appropriate for the OSC to take the lead for the oil spill countermeasures.
- o If ice conditions delay relief well activities, a comprehensive plan should be developed for a long-term spill cleanup operation.
- o The OSC should work closely with the National Marine Fisheries Service and the U.S. Fish and Wildlife Service to set priorities for protecting marine mammals and migratory waterfowl from the spill.

4.10.8 Blowout Safety Considerations

It is essential for the OSC to recognize that a blowing well may release toxic gases and create an explosion hazard. Additionally, the smoke created by a burning well contains soot and

polynuclear aromatic hydrocarbons which are known to cause cancer in living tissue. Therefore, personnel or aircraft should not approach a blowing well until the Operator has eliminated these hazards. Personnel working at or near a blowing well should wear respiratory protection effective against hydrogen sulfide, organic vapor, and acid gas.

4.11 DISPERSANTS

4.11.1 General Description

Dispersants are chemicals that reduce the interfacial tension between oil and water. This enables the natural energy of the marine environment to break an oil slick into tiny droplets and suspend them in the water column. Afterwards, the oil undergoes a number of natural reactions such as oxidation, biodegradation, and other processes which eventually convert it to water, carbon dioxide, oxygen, inorganic salts and inert materials. Under the right conditions, dispersants may minimize the environmental impact that oil spills could have on shorelines and coastal resources.

In many offshore regions, oil spill response effectiveness can be restricted by sea state or equipment limitations. Normally, high sea states which prohibit the use of mechanical recovery equipment provide sufficient wave energy for enhancing the effectiveness of chemical dispersants. This section will highlight the criteria for dispersant effectiveness and the decision process for dispersant use.

4.11.2 Criteria For Dispersant Effectiveness

The following factors play a key role in determining whether dispersants will be effective as an oil spill response countermeasure:

- Sea State. Wave energy is required to break an oil spill into droplets and provide the turbulence necessary for carrying these droplets away from the slick. Field tests performed by Canadian scientists show that if the wave height is less than 0.3 feet, dispersant effectiveness will be low.

- Dose Rate. Although some laboratory tests reveal that one part dispersant may be sufficient to disperse 80 parts oil, field tests demonstrate that much higher dose rates may be required for oil spills in an offshore environment. For example, field trials indicate that the dose rates may range from one part dispersant to twenty parts oil to as high as one part dispersant to five parts oil.

  The reason for higher dose rates is that oil slicks do not have a uniform thickness. For example, some slicks may have as much as ninety percent of their oil in ten percent of the area that they cover. Therefore, if the entire slick is sprayed with the same dispersant dose rate, the dispersant operation will not be successful.

- Oil Viscosity. Laboratory tests prove that dispersants do not mix well with oils which have viscosities greater than 2,000 cSt. This means that the dispersants may not be effective for highly weathered oils, heavy oils such as Bunker C, and heavy emulsions.

- Oil Composition. Each dispersant varies in its ability to disperse different oils because each oil has a unique chemistry. To improve the potential for dispersant effectiveness, preliminary work should be performed to identify the best dispersant for the oil spill before a full scale dispersant deployment operation begins. (This can be accomplished by conducting small scale dispersant effectiveness tests at the Alaska Clean Seas' warehouse. These tests should include samples of the oil before and after the spill, the available dispersants, and Beaufort Sea water.)

- Salinity. Although many dispersants perform well in salt water, no dispersants are capable of effectively dispersing oil in fresh water. Therefore, it is questionable whether dispersants would be effective in the Beaufort Sea coastal environment where the salinity is low due to fresh water runoff. Since melting ice will also reduce sea water salinity, dispersants may not be effective during the broken ice season.

- Time Since Discharge. Along with the previous considerations, an oil spill must contain a significant portion of its volatile hydrocarbons (light ends) in order for dispersants to work. Since the light ends begin to evaporate as soon as the spill occurs, dispersants must be applied within 24 to 48 hours. In other words, dispersant effectiveness decreases with time.

A summary of dispersant effectiveness for various oil spills is provided in Table 4.11.2.

4.11.3 Authorization For Dispersant Use

The procedure for authorizing dispersant use is provided in Subpart H of the National Oil and Hazardous Substances Pollution Contingency Plan. In accordance with Section 300.84 of this Plan, the federal On-Scene Coordinator, with the concurrence of the EPA representative on the Regional Response Team and the states with jurisdiction over navigable waters polluted by the oil spill, may authorize the use of any dispersant or chemical agent on the National Contingency Plan Product Schedule (Table 4.11.3).

If, however, the On-Scene Coordinator deems that dispersant use is necessary to prevent or substantially reduce a hazard to human

Table 4.11.2

DATA FROM DISPERSANT EFFECTIVENESS TRIALS

Number	Oil Type	Viscosity (cSt) (20°C)	Spill Amount (m^3)	Dispersant	Application Method	Dose Rate O:D	Sea State	Effectiveness (%)	Assigned Effectiveness[1]
1	Ekofisk	8	0.5	10% Conc.	Ship, WSL	-	1	-	Less than 10%
2	Kuwait	14	-	10% Conc.	Ship, WSL	20:1	2-3	100	-
3	Murban	5	1.7	Corexit 9527	Helicopter	Greater than 5:1	1	-	Less than 10%
4	La Rosa	80	1.7	Corexit 9527	Helicopter	Greater than 5:1	1	-	10-50%
5	Murban	5	1.7	Corexit 9527	Helicopter	Greater than 11:1	1	100	-
6	La Rosa	80	1.7	Corexit 9527	Helicopter	Greater than 11:1	1	50	-
	Prudhoe Bay	35	1.6	Control	Control	-	2-3	0.5	-
7	Prudhoe Bay	35	1.6	2% Conc.	Ship	67:1	2-3	8	-
8	Prudhoe Bay	35	1.6	2% Conc.	Ship	67:1	2-3	5	-
9	Prudhoe Bay	35	3.2	Conc.	Airplane, DC-4	20:1	2-3	78	-
10	Prudhoe Bay	35	1.6	Conc.	Airplane, DC-4	25:1	2-3	45	-
	Prudhoe Bay	35	1.6	Control	Control	-	2-3	1	-
11	Prudhoe Bay	35	3.2	Conc.	Airplane, DC-4	27:1	2-3	60	-

Reference: Spill Technology Newsletter, Environment Canada, 1985.

Table 4.11.2 (Continued)

DATA FRC.: DISPERSANT EFFECTIVENESS TRIALS

Number	Oil Type	Viscosity (cSt) (20°C)	Spill Amount (m^3)	Dispersant	Application Method	Dose Rate O:D	Sea State	Effectiveness (%)	Assigned Effectiveness[1]
12	Prudhoe Bay	35	1.6	2%	Ship	11:1	2-3	11	-
13	Prudhoe Bay	35	1.6	2%	Ship	11:1	2-3	62	-
14	Light Fuel	35	6.5	Dispolene 325	Airplane, CL215	Greater than 3:1	1-2	50	-
15	Light Fuel	35	6.5	Shell	Airplane, CL215	Greater than 3:1	2-3	-	10-50%
	Light Fuel	35	6.5	Control	Control	---	1-2	-	-
16	North Slope	70	0.2	10%, 9527	Ship, WSL	1:1	2	-	Less than 10%
17	North Slope	70	0.4	10%, 9527	Ship, WSL	1:1	1	-	Less than 10%
18	North Slope	70	0.2	10%, 9527	Ship, WSL	1:1	1	-	Less than 10%
	Statfjord	17	0.2	Control	Control	---	2-3	0.6	-
19	Statfjord	17	0.2	10% Conc.	Ship	Greater than 10:1	2-3	6	-
20	Statfjord	17	0.2	10% Conc.	Ship	10:1	2-3	17	-
21	Statfjord	28	0.2	Control	Control	---	2-3	2.6	-
22	Statfjord	28	0.2	10% Conc.	Ship	17:1	2-3	19	-
23	Statfjord	28	0.2	10% Conc.	Ship	18:1	2-3	22	-
24	Statfjord	28	0.2	10% Conc.	Ship	13:1	2-3	2	-
	Arabian	10	20	Control	Control	---	1	-	-

Reference: Spill Technology Newsletter, Environment Canada, 1985.

Table 4.11.2 (Continued)

DATA FROM DISPERSANT EFFECTIVENESS TRIALS

Number	Oil Type	Viscosity (cSt) (20°C)	Spill Amount (m^3)	Dispersant	Application Method	Dose Rate O:D	Sea State	Effectiveness (%)	Assigned Effectiveness[1]
25	Arabian	170	20	Corexit 9527	Airplane Isl.	2:1	1	-	Less than 10%
26	Arabian	385	20	Corexit 9527	Airplane, Isl.	4:1	1	-	Less than 10%
27	Light Fuel	100	3	10% Dispolene 325	Ship	Greater than 2:1	3	-	10-50%
28	Light Fuel	100	5	Dispolene 325	Airplane,	Greater than 2.4:1	3	-	40-75%
29	Light Fuel	100	5	Dispolene 325	Ship	Greater than 2.8:1	2	-	10-50%
30	Light Fuel	100	5	Dispolene 325	Airplane, CL215	Greater than 2.8:1	2	-	40-75%
31	Light Fuel	250	3.5	Dispolene 325	Ship	Greater than 2.6:1	1-2	-	10-50%
32	Light Fuel	100	4	Dispolene 325	Helicopter	Greater than 2.9:1	1-2	-	10-50%
33	Light Fuel	100	2	Premixed	Premixed	20:1	1-2	40-50	-
	Light Fuel	100	5	Control	Control	---	2	-	-
	Statfjord	8	2	Control	Control	---	1-2	2	-
	Light Fuel	60	2	Control	Control	---	1-2	2	-
	Statfjord	8	2	Control	Control	---	1	2	-
34	Statfjord	8	2	Finasol OSRS	Airplane	10-30:1	1	2	-

Reference: Spill Technology Newsletter, Environment Canada, 1985.

Table 4.11.2 (Continued)

DATA FROM DISPERSANT EFFECTIVENESS TRIALS

Number	Oil Type	Viscosity (cSt) (20°C)	Spill Amount (m^3)	Dispersant	Application Method	Dose Rate O:D	Sea State	Effectiveness (%)	Assigned Effectiveness[1]
35	Light Fuel	60	2	Finasol OSRS	Airplane	10-30:1	1	2	-
36	Statfjord	8	2	Finasol OSRS	Premixed	20:1	2-3	100	-
37	Light Fuel	60	2	Control	Control	---	2-3	2	-
38	Statfjord	9	2	Finasol OSRS	Airplane	10-30:1	1-2	2	-
39	Statfjord	9	2	Finasol OSRS	Airplane	10-30:1	1-2	2	-
40	ASMB	7	2.5	Corexit 9527	Helicopter	20:1	1	1.5	-
	ASMB	7	2.5	Control	Control	---	1	Less than 0.5	-
41	ASMB	7	2.5	Corexit 9550	Helicopter	10:1	1	10	-
	ASMB	7	2.5	Control	Control	---	1	Less than 0.5	-
42	ASMB	7	2.5	BP MA700	Helicopter	10:1	2-3	16	-
	ASMB	7	2.5	Control	Control	---	2-3	4.3	-
	Statfjord	12	10	Control	Control	---	1	-	-
43	Statfjord	12	10	Corexit 9527	Airplane, Isl.	75:1	1	-	40-75%
	Statfjord	12	10	Control	Control	---	2	-	-
44	Statfjord	12	10	Corexit 9527	Airplane	80:1	2	-	40-75%

Reference: Spill Technology Newsletter, Environment Canada, 1985.

Table 4.11.2 (Continued)

DATA FROM DISPERSANT EFFECTIVENESS TRIALS

Number	Oil Type	Viscosity (cSt) (20°C)	Spill Amount (m^3)	Dispersant	Application Method	Dose Rate O:D	Sea State	Effectiveness (%)	Assigned Effectiveness[1]
45	Statfjord	12	12	Corexit 9527	Premixed	33:1	2	-	90-100%
46	Statfjord	12	10	Corexit 9527	Airplane	50:1	-	-	75-90%
	Fuel Oil	40	5	Control	Control	---	(1	-	-
47	Fuel Oil	40	28	Dispolene 355	Helicopter	?	(1	-	Less than 10%
48	Fuel Oil	40	part of above	Dispolene 355	Ship-Spray	?	(1	-	10-50%
49	Fuel Oil	40	part of above	Dispolene 355	Ship-Aerosol	?	1	-	10-50%

Abbreviations: ASMB - Alberta Sweet Mixed Blend
Conc. - Concentrate
Isl. - Islander
WSL - Warren Spring Laboratory

[1] The effectiveness of the tests were assigned by the author.

Reference: Spill Technology Newsletter, Environment Canada, 1985.

Table 4.11.3

ENVIRONMENTAL PROTECTION AGENCY NATIONAL CONTINGENCY PLAN PRODUCT SCHEDULE
August 1988

Dispersant	Manufacturer	Location	Phone Number
BP-1100X (Hydrocarbon Solvent Based)	BP Detergents, Ltd.	Scotland	0506-31111
Cold Clean 500 (Water Based)	Essex Fire & Safety Company	Texas	(713) 641-3616
Conco Dispersant K	Continental Chemical Company	New Jersey	(201) 472-5000
Corexit 7664 (Water Based)	Exxon Chemical Company	Texas	(713) 670-1702
Corexit 8667 (Hydrocarbon Solvent Based)	Exxon Chemical Company	Texas	(713) 670-1702
Corexit 9527 (Concentrate)	Exxon Chemical Company	Texas	(713) 670-1702
EC.O Atlan'tol AT7 (Water Based)	ASPRA, Inc.	Washington	(206) 284-9838
Finasol OSR-7 (Water Based Concentrate)	American Petrofina, Inc.	Texas	(214) 750-2640
Gold Crew Dispersant (Water Based Concentrate)	ARA Chem, Inc.	California	(619) 286-4131
Magnotox (Water Based Concentrate)	Magnus Maritec Int'l, Inc.	New Jersey	(201) 592-0700
OFC D-609 (Concentrate)	Chem Link Petroleum, Inc.	Oklahoma	(918) 245-2224
Oil Spill Eliminator N/T No. 4 (Hydrocarbon Solvent Based)	Petrocon Marine and Chemical Corporation	New York	(212) 499-3111
OSD/LT Oil Spill Dispersant (Concentrate)	Drew Chemical Corporation	New Jersey	(201) 263-7817
Petro-Green ADP-7 (Water Based Concentrate)	Petro-Green, Inc.	Texas	(214) 484-7336
Petromend, MP-900-W (Water Based Concentrate)	Petromend, Inc.	Texas	(214) 630-1330
Proform-Pollution Control Agent (Water Based Concentrate)	Proform Products Corporation	California	(415) 321-5207
Slik-A-Way (Water Based)	Mi-Dee Products, Inc.	California	(415) 846-8166

Table 4.11.3 (cont'd)

ENVIRONMENTAL PROTECTION AGENCY NATIONAL CONTINGENCY PLAN PRODUCT SCHEDULE
August 1988

Dispersant	Manufacturer	Location	Phone Number
Dispersant 11 (Concentrate)	Dubois Chemicals	Ohio	(513) 762-6894
Tops All #30 (Oil and Petroleum Cleaning Agent)	Stutton North Corporation	Louisiana	(504) 626-3900
Corexit 9550 (Hydrocarbon Solvent Based)	Exxon Chemical Company	Texas	(713) 670-1702
Jansolv-60 Dispersant (Principally Water Based with some Solvent)	Sunshine Technology Corporation	Connecticut	(203) 232-9227
Ruffnek (Oil and Petroleum Cleaning Agent)	Malter International Corporation	Louisiana	(504) 362-3232
NEOS AB 3000 (Hydrocarbon Solvent Based)	Neos Company Limited	Japan	(078) 331-9381
Crudex (Organic Surfactant Based)	Environmental Security, Inc.	Pennsylvania	(717) 392-1251
Bio Solve (Water Based)	Metra Chem Corporation	Massachusetts	(617) 845-1193
NK-3 (Water Based)	GFC Chemical Company	Louisiana	(318) 234-8262
Enersperse 700 (Solvent Based)	BP Detergents Limited	Scotland	(011-44-506) 31111
Slickgone NS (Solvent Based)	DASIC International, Ltd	England	(0794) 512419
Mare Clean 505 (Solvent Based)	Mitsubishi International Corp.	New York	(212) 605-2433
Surface Collecting Agents			
Corexit OC-5	Exxon Chemical Company	Texas	(713) 670-1702
Oilcompress/Oilbinder (Nalco #3WP-086) (Adair Corralit)	Listex Chemicals	Texas	(214) 297-3244
Oil Herder	ASI, Inc.	California	(213) 436-0211

life, he may authorize the use of any chemical agent at his discretion.

The National Contingency Plan also includes provisions which encourages the Regional Response Team to develop pre-approved guidelines for dispersant use. The objective for this is to expedite the decision process for dispersant approval. Currently, the Alaska Regional Response Team is developing dispersant use guidelines for Alaska. It is expected that pre-approved dispersant use guidelines will be drafted for the Beaufort Sea during 1987.

4.11.4 Issues Regarding Dispersant Use

Dispersant use is a controversial issue in the State of Alaska. Industry and some government organizations view dispersants as an appropriate countermeasure for oil spills that threaten critical wildlife habitats or areas where natural conditions would prohibit the use of mechanical equipment. On the other hand, native residents, commercial fishermen, and some environmental groups believe that chemically dispersed oil would have a detrimental impact on aquatic wildlife and subsistence resources.

In view of the controversy surrounding dispersants, the OSC should answer the following question prior to recommending dispersant use:

"Which would be more detrimental to the environment - oil on the water surface or chemically dispersed oil in the water column?"

The toxicity of the dispersants presently stockpiled for use in U.S. waters is low compared to that of petroleum hydrocarbons. As noted in Table 4.11.4, many of the dispersants which are currently accepted for use in U.S. waters by the Environmental Protection Agency have a high effectiveness but a very low toxicity with respect to crustacean zooplankton.

In reality, the possibility of exposing organisms to lethal concentrations of dispersants or dispersed oil in an open ocean environment for extended periods of time is extremely low. As a result, it is unlikely that dispersants or chemically dispersed oil would cause fatalities to marine organisms or aquatic wildlife in an open ocean environment with sufficient mixing energy.

With respect to the potential impact that chemically dispersed oil could have on the environment, many environmental groups turn to laboratory studies which suggest that mixtures of oil and dispersant are more toxic to aquatic wildlife than oil. The rationale for this is as follows:

Table 4.11.4

DISPERSANT TOXICITY

Relative effectiveness and toxicity of some chemical dispersants on the U.S. Environmental Protection Agency approval list to *Mysidopsis bahia*, a crustacean zooplankton (Anderson et al., 1985).

Dispersant	(15°C) Dispersant: Oil Ratio(1) (DOR_{90})	(25°C) 96-h LC_{50}(2) ppm
Atlantol AT-7	0.130	6.6
BP1100WD	0.009	1.4
Finasol OSR-7	0.038	204.0
Arcochem D-609	0.007	29.0
Corexit 9527	0.009	31.9
Corexit 7664	0.500	515.0
Corexit 8667	0.028	2.0
Petrocon N/T#4	0.018	15.0
Ameriod OSD/LT	0.110	6.7
Slick-A-Way	2.240	16.0
Conco K	0.580	3.5
BP1100X	0.150	17.0
Magnus Maritec	0.012	8.0
Petromend	0.008	3.7

Note 1. DOR_{90} is the ratio of dispersant to oil required to disperse 90% of the oil.

2. LC_{50} is the lethal concentration required to kill 50 percent of a test species during a 96-hour exposure period.

"If the oil is allowed to remain on the water surface, its toxicity would decrease because most of the toxic light ends would evaporate. If dispersants are used, the toxic light ends would be forced into the water column and contaminate aquatic wildlife that would never be exposed to the oil if it remained on the water surface. Additionally, chemically dispersed oil will undergo a number of reactions that will remove oxygen from the water. This could also have a negative impact on aquatic wildlife."

Commercial fisherman in Alaska believe that the U.S. Food and Drug Administration would prohibit the sale of fish which are exposed to chemically dispersed oil. Since this could adversely impact their livelihood, they are opposed to dispersant use. Similarly, Alaskan Eskimos who rely upon aquatic wildlife for their nutritional needs also oppose the use of dispersants because they believe their health will suffer if they consume animals which have been exposed to chemically dispersed oil. So far no one has provided sufficient data to show that these concerns are not justified.

4.11.5 Dispersant Equipment and Logistics

There are two industry-sponsored oil spill response cooperatives in Alaska: Alaska Clean Seas (ACS) and Cook Inlet Response Organization (CIRO). Both organizations have dispersant spray kits that can be mounted on helicopters as shown in Figure 4.11.5.1. Each kit includes a "slung bucket" that can contain up to 600 gallons of dispersant. Helicopters necessary for deploying the dispersant spray kits can be obtained from ERA Helicopters Inc. (907/248-4422) or Evergreen Helicopters of Alaska, Inc. (907/276-2454).

ACS has a 65-foot oil spill response vessel (ARCAT Skimmer) at Prudhoe Bay which is capable of deploying dispersants (Figure 4.11.5.2). Conair Aviation Ltd. (Abbotsford, British Columbia (604/853-1171)) has seven Douglas DC-6B aircraft which can be used for dispersant deployment. Each aircraft is capable of transporting 3,850 gallons of dispersant 1,375 miles. At an average dose rate of 1 Bbl. of dispersant for 20 Bbls of oil, each DC-6B can treat 1,833 Bbls. of oil.

In addition to Conair Aviation Ltd., Biegert Aviation (Chandler, Arizona (602/895-0448)) can also be contracted to deploy dispersants. Biegart Aviation has an Airborne Dispersant Delivery System (ADDS) which is a self-contained dispersant spray package (Figure 4.11.5.3). ADDS can be installed on a C-130 Hercules aircraft and can hold approximately 5,500 gallons of dispersant. Once deployed, ADDS can release dispersants at a rate of 100 to 200 gallons per minute.

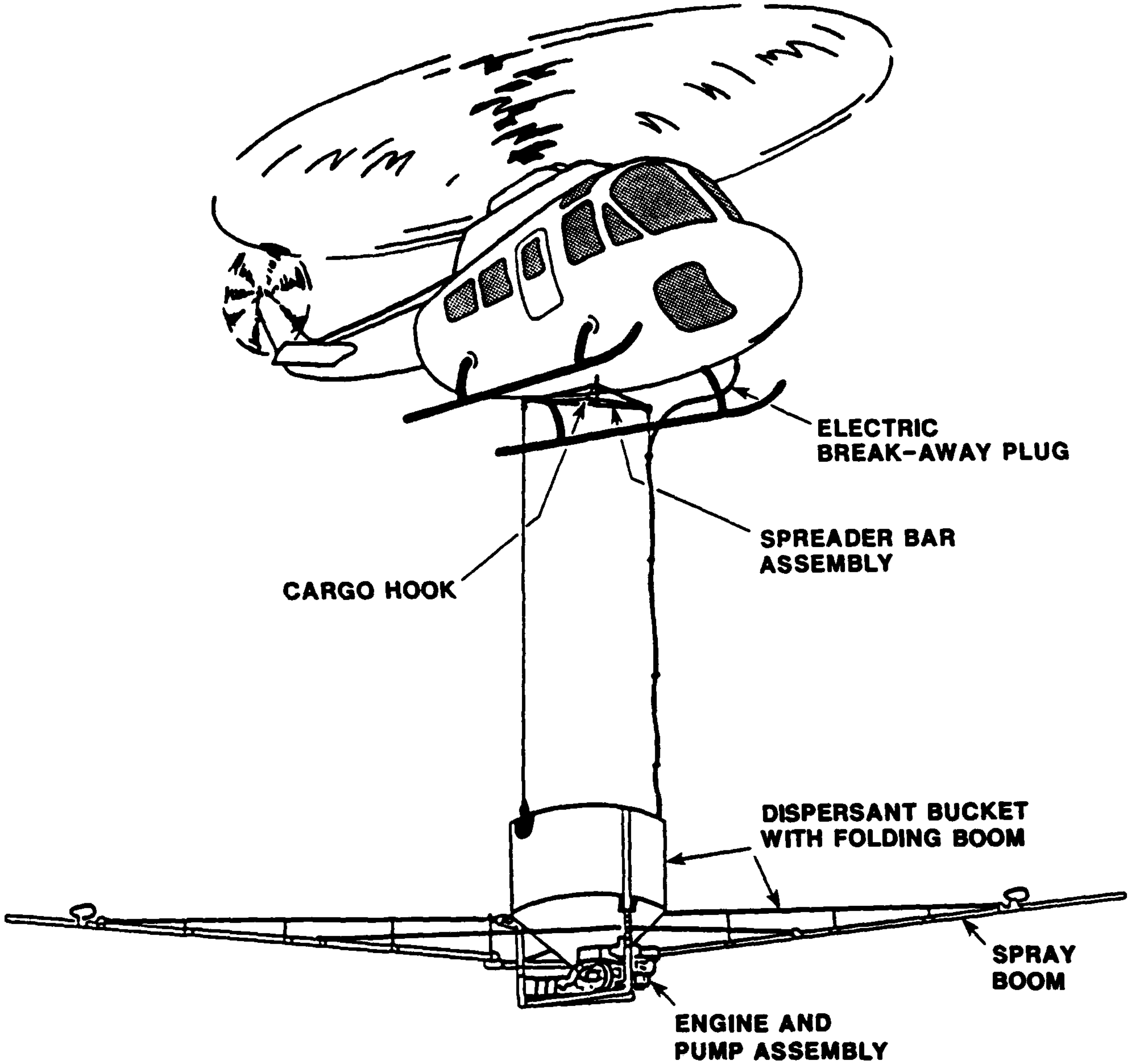
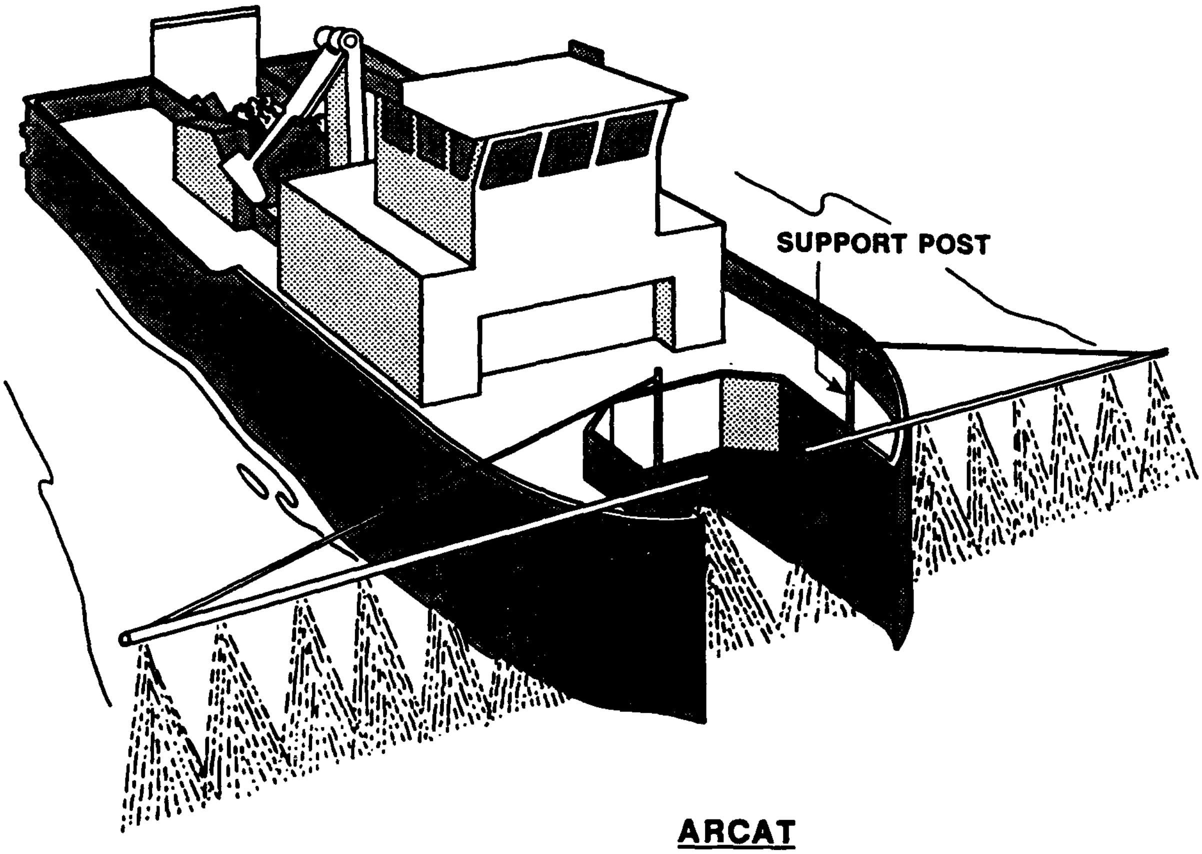


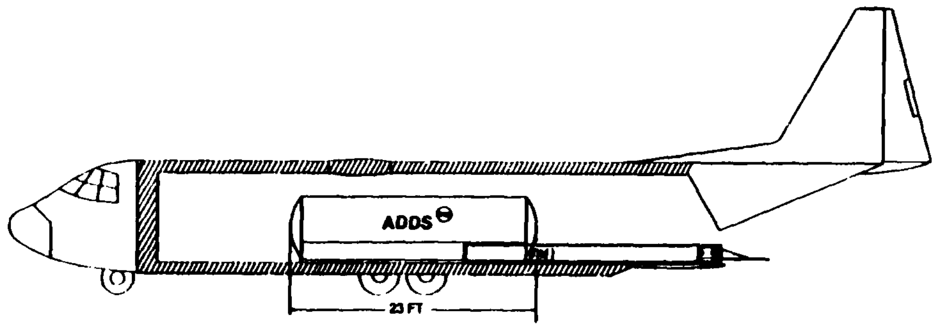
Figure 4.11.5.1	SIMPLEX HELICOPTER-SLUNG SPRAYER



ARCAT

DEDICATED 65-FT. OIL-RECOVERY AND DISPERSANT-SPRAY VESSEL LOCATED AT PRUDHOE BAY, ALASKA

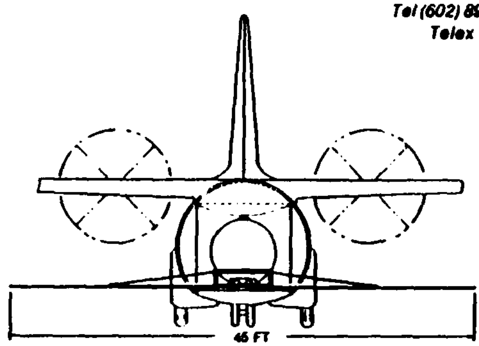
Figure 4.11.5.2	ARCAT WITH DISPERSANT SPRAY BOOM

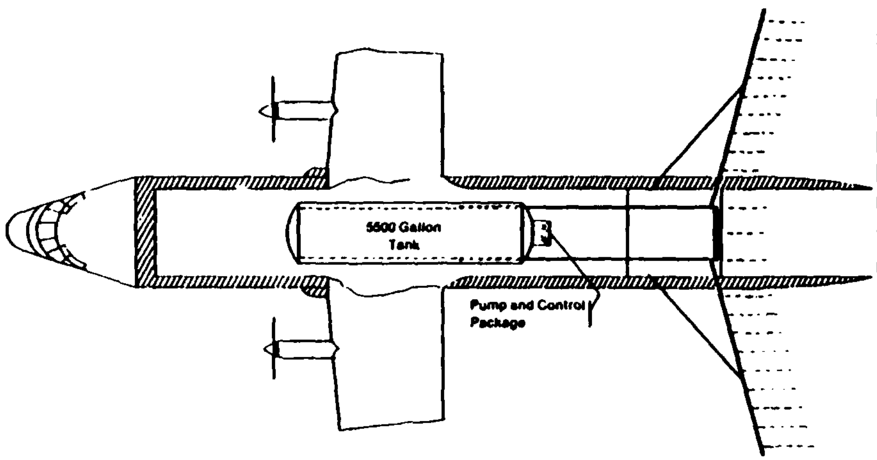


FOR FURTHER INFORMATION CONTACT

Biegert Aviation Inc.

Memorial Airport
22022 S. Price Rd.
Chandler, AZ 85224
Tel (602) 895-0441
Telex 165775





SPECIFICATIONS:

CAPACITY	5500 gal. dispersant
FLOW RATES	100 to over 600 gpm
UNIT DRY WEIGHT	4500 lbs.
WORK RATE	Up to 500 tons of oil per sortie
FERRY SPEED	345 mph
WORK SPEED	150 - 170 mph
PUMPS	Dual centrifugal
CONTROL	Full remote control from cockpit
FEATURES	Electronic flow data
	Clean electric operation
	Adjusts to fit any suitable airplane
	Installs or removes in under 30 minutes

Figure 4.11.5.3

AIRBORNE DISPERSANT DELIVERY SYSTEM

The following dispersants are stockpiled in Alaska:

Owner	Type	Drums	Location
Alaska Clean Seas	COREXIT 9527	10	Deadhorse
Alaska Clean Seas	COREXIT 9527	160	Anchorage
Alaska Clean Seas	COREXIT 9527	10	Dutch Harbor
Alaska Clean Seas	COREXIT 9527	10	Nome
Alyeska	COREXIT 9527	25	Valdez
Cook Inlet Response Organization	COREXIT 9527	86	Kenai
Cook Inlet Response Organization	COREXIT 9527	210	Kenai
Alaska Clean Seas	ARCo D-609	10	Deadhorse

Points of contact for the organizations in Alaska which stockpile dispersants are as follows:

Dispersant Owner	Point of Contact	Phone Number
Alaska Clean Seas	Mr. R.M. Johnson	(907) 345-3142
Alyeska	Mr. B. Hilliker	(907) 265-8174
Cook Inlet Response Organization	Mr. R.B. Eldridge	(907) 776-5129

These individuals can also be contacted to gain access to any dispersant application equipment owned by their organization. Additional dispersants can be obtained from dispersant manufacturers in the Lower-48. For example, dispersants can be airlifted from Exxon Chemical Company (Houston, Texas) to Prudhoe Bay by C-130 Hercules aircraft in less than 24 hours.

4.11.6 Alaska Dispersant Symposium

During a September 1983 Dispersant Symposium in Anchorage, Alaska, Commander Roger Rufe, (U.S. Coast Guard) commented that the opportunity for dispersant effectiveness passes rapidly with time. Therefore, advanced planning is needed to ensure timely application. He stated that helicopters cannot transport enough dispersants for a large operation and workboats are too slow. Large aircraft such as the Douglas DC-6B or C-130 Hercules aircraft are the best alternative for dispersant application in an offshore environment.

Based on 1983 figures, Coast Guard estimates indicate that it will cost $12 to $26 for each gallon of dispersant used to treat a large spill. This includes the cost for dispersant purchase, shipment, and application. For example, the cost for treating a 55,000-Bbl. spill with a 1:20 dispersant to oil ratio would be approximately $1.4 to $3 million dollars. Commander Rufe pointed out that aircraft and dispersant availability as opposed to cost, would be the limiting factor for a successful dispersant operation in Alaskan waters.

Most crude oils with viscosities less than 50 cSt are amenable to dispersant treatment. The limit on dispersibility for crude oils is in the range of 7,500 cSt at sea temperature. Pour point is another consideration for dispersant effectiveness. If the sea temperature is below the pour point, the oil will solidify on contact with the sea regardless of its quoted viscosity at 100°F. Hence, oils which may be dispersible in temperate waters may not be dispersible in the colder waters found in the Beaufort Sea. Therefore, limiting factors with respect to dispersant effectiveness in the Beaufort Sea are: 1) the water is colder, and 2) the salinity may be low due to surface runoff and melting ice. Consequently, it is questionable whether dispersants would be effective for this region.

During the September 1983 Dispersant Symposium in Anchorage, Alaska, the Alaska Regional Response Team (RRT) conducted a scenario workshop. With respect to the Beaufort Sea, the EPA representative on the RRT commented that there are too many unknowns about the fate and affects of dispersed oil in the Beaufort Sea. Therefore, the EPA may be unwilling to give a blank check for dispersant use in this region. He stated that industry should put forth more effort to resolve data gaps associated with questions regarding dispersant effectiveness and toxicity in Arctic waters.

4.11.7 Summary

Chemical dispersants should be considered as one of several tools available to the On-Scene Coordinator for minimizing the impact of oil spills. They offer the following advantages:

- Dispersants (under some conditions) can remove oil slicks from the water surface, thereby reducing the potential for adverse impact to aquatic birds, sea mammals, shorelines, and fishing equipment.

- Dispersants aid in breaking slicks into tiny droplets which enhance the potential for biodegradation and decomposition due to natural forces.

- Dispersants can eliminate sheens that remain on the water surface after mechanical removal has been completed.

- Dispersants may be effective in areas where environmental or logistical considerations will not allow the deployment of cleanup equipment and personnel.

- Dispersants may reduce the overall level of effort and manpower requirement necessary for responding to major spills.

Some of the disadvantages inherent to chemical dispersants are as follows:

- They may not be effective for oil spills in Arctic waters with low temperatures, low salinity, or broken ice.
- They may accelerate the transfer of oil into the water column and thereby create high localized concentrations of dispersant/oil mixtures which could be toxic to some aquatic life. In view of this, it may not be appropriate to use dispersants in shallow coastal waters.
- Dispersants are generally not effective for emulsified or weathered oil.
- Local interest groups and environmental organizations may oppose dispersant use.
- Dispersant use may eliminate the possibility of future recovery of oil slicks by some mechanical techniques.
- Dispersants must be applied within 24-48 hours after the spill occurs or they may not be effective due to natural forces which change the properties of the oil.
- Chemically dispersed oil undergoes a number of chemical reactions which remove oxygen from the water column. Therefore, oxygen depletion could negatively impact aquatic wildlife or organisms in a calm near-shore aquatic environment.
- The impact of chemically dispersed oil on subsistence resources in the Beaufort Sea is unknown.

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5.0 MECHANICS OF RESPONSE

This section of the Planning Guide contains tables, checklists and figures which are designed to help develop the best strategy for responding to oil spills in the Alaskan Beaufort Sea. It also addresses other sections in the Planning Guide which provide additional information for the response options under consideration.

This is the first section of the Planning Guide that should be reviewed when a spill report is received. In order of priority, the response considerations listed in Table 5.1 should be reviewed first. This should be followed with Checklist 1. This checklist will direct the user to other checklists, tables, and figures contained in this section.

After the response strategy has been identified, Section 3.0 should be reviewed. This section, Initial Response, will provide additional insight for initiating the response operation. As new information about the spill becomes available or if the environmental conditions change, the decision trees in Figures 5.2 through 5.8 should be used to revise the response strategy as required.

By using this section in conjunction with Section 6.0, Oil Spill Response Scenarios, a valuable training aid is provided for oil spill response planning. For example, each scenario describes the event, environmental conditions, and behavior for a specific spill. This information and the decision trees in Figures 5.2 through 5.8 can be used by the OSC to develop a response strategy. Afterwards, this strategy can be compared to the planning process and response actions presented in the scenarios.

Table 5.2 provides a summary of safety considerations for hydrogen sulfide. Table 5.3 summarizes the classification and properties of various oils. Table 5.4 provides a generic summary of oil spill response techniques for the Beaufort Sea. Table 5.5 provides an overview of general oil spill response priorities.

Table 5.1

RESPONSE CONSIDERATIONS

- o Oil well blowouts may release toxic gases, such as hydrogen sulfide, which are hazardous to human health. (See Table 5.2).
- o Well ignition may eliminate safety hazards created by toxic gases. (See Section 4.10).
- o The potential for fire and/or explosion may exist during the initial phase of a spill.
- o Oil spills may contain toxic compounds. (See Table 5.3).
- o Personnel safety should receive top priority.
- o No single technique will provide complete oil spill containment or recovery.
- o Beaufort Sea weather conditions frequently change.
- o Large quantities of oil spill response equipment are stockpiled in Alaska. (See Table 4.0.1).
- o As a general rule, most oil spill response techniques have seasonal limitations. (See Figure 4.0).
- o Sufficient personnel with adequate oil spill response training may not be immediately available in Alaska.
- o State and federal regulations limit disposal options for recovered oil. (See Section 4.7).

Checklist 1

IMMEDIATE ACTIONS FOR BEAUFORT SEA OIL SPILLS

- ___ Complete notifications on Checklist 2.
- ___ Request Prudhoe Bay charter service to begin aerial surveillance of spill.
  - ___ ERA Helicopters, Inc., (907) 659-2465.
  - ___ Evergreen Helicopters of Alaska, Inc. (907) 659-2457.
  - ___ Sea Airmotive, Inc. (907) 659-2634.
- ___ Review Figures 5.1 and 5.2.
- ___ Determine if spiller will assume responsibility for the containment and cleanup operation.
- ___ If the spiller is unknown or if the spiller will not assume immediate responsibility for containment and cleanup, the On-Scene Coordinator should:
  - ___ Use Oil Spill Cleanup Contractors for initial response. (See Checklist 2).
  - ___ Mobilize Pacific Strike Team (415-883-3311) for blowouts or spills greater than 1,000 Bbls, (except during winter).
  - ___ Request NOAA to prepare oil spill trajectory analysis. (206) 526-6317.
  - ___ Meet with Scientific Support Coordinator (907-271-3593) and Alaska Regional Response Team (907-586-7195 / 907-271-5083), to develop and prioritize response strategy.
  - ___ Request permission to use Alaska Clean Seas Equipment and Prudhoe Bay basecamp. (907) 345-3142.
  - ___ Monitor Beaufort Sea weather.
  - ___ For blowouts, review Checklist 3, Table 5.2, and Figures 5.3 and 5.4.

Checklist 2

NOTIFICATIONS FOR BEAUFORT SEA OIL SPILLS

- ___ Advise Alaska Regional Response Team that its support may be required. (907) 586-7195/(907) 271-5083.
- ___ Request Scientific Support Coordinator to provide technical support. (907) 271-3593.
- ___ Place the Pacific Strike Team on standby for spills greater than 1,000 barrels. (415) 883-3311.
- ___ Place cleanup contractors on standby.
  - ___ Ajit Shah, Inc., (907) 344-2625.
  - ___ Alaska Offshore, Inc., (907) 349-4578.
  - ___ Crowley Environmental Services Corp., (907) 344-1511.
- ___ Notify Alaska Clean Seas that its response equipment may be required. (907) 345-3142.
- ___ Notify charter air service that flights to Prudhoe Bay may be required.
  - ___ MarkAir, (907) 266-6230.
  - ___ ERA Helicopters, Inc. (907) 248-4422.
  - ___ Evergreen Helicopters of Alaska, Inc. (907) 276-2454.
- ___ Notify North Slope Borough Land Management Administrator that spill has occurred. (907) 852-2611, Ext. 245.

Checklist 3

RESPONSE ACTIONS FOR OIL WELL BLOWOUT

Man-made or Natural Islands

___ Review Blowout Decision Tree (Figure 5.3).

___ Request and review Operator's Well Control Plan.

___ Request Operator's Relief Well Plan.

___ Discuss Well Control Plan with Well Control Contractors.

- ___ Boots and Coots, Inc., (713) 931-8884.
- ___ Red Adair Co., Inc., (713) 464-0230.
- ___ Wild Well Control, Inc., (713) 353-5481.

___ Make well ignition decision. (See Checklist 4).

___ Mobilize Pacific Strike Team if blowout occurs during broken ice or open water seasons.

Drillship or other Floating Structures

___ Help operator obtain drillship or equipment from Canada. (Consult with operator for this.)

___ Mobilize U.S. Coast Guard ice breakers to assist relief well operation.

Table 5.2

HYDROGEN SULFIDE SAFETY CONSIDERATIONS

AND HEALTH IMPACTS[1]

H_2S Concentration	Safety Considerations
1 PPM = .0001%	Detectable by odor, irritation of respiratory tract.
10 PPM = .001%	Allowable for eight (8) hours exposure (OSHA).
20 PPM = .002%	OVER 20 PPM - PROTECTIVE EQUIPMENT WILL BE NECESSARY.
100 PPM = .01%	Sense of smell lost in 3 to 5 minutes. May burn eyes and throat, may cause coughing.
200 PPM = .02%	Destroys sense of smell rapidly. Eyes and throat burn.
500 PPM = .05%	Respiratory disturbances in 2 to 25 minutes. Coughing, collapse, and unconsciousness may occur.
700 PPM = .07%	May cause unconsciousness - breathing stops. Death will occur unless artificial resuscitation is given immediately.
1,000 PPM = .10%	Immediate unconsciousness. Brain damage may result unless proper first aid is given. Death may occur in 3-5 minutes.

Notes:
1. Hydrogen Sulfide (H_2S) is colorless and smells like rotten eggs (stinks).
2. H_2S may be released by oil or gas blowouts.
3. H_2S is deadly and smell should not be used as the primary means to detect it.

Table 5.3

CLASSIFICATION AND PROPERTIES OF OIL

OIL TYPE	PHYSICAL/CHEMICAL PROPERTIES	TOXICOLOGICAL PROPERTIES
Light, volatile oils	-Spread rapidly -High evaporation and solubility rates -Tend to form unstable emulsions -Very toxic to biota when fresh -May penetrate intertidal sediment -Can be removed from surfaces by simple agitation and low pressure flushing	-Acute toxicity is related to the content and concentration of aromatic fractions -Aromatic fractions are very toxic due to the presence of napthalene and benzene compounds. -Some heavy molecular weight compounds are either known or potential carcinogens -Acute toxicity of individual aromatic fractions will vary among species due to differences in the rate of uptake and rate of release of these compounds -Marsh plants may be chronically affected due to penetration and persistence of aromatic compounds in sediments
Moderate to heavy oils	-Moderate to high viscosity -Toxicity variable depending on light fraction -Tend to form stable emulsions under high energy conditions -Variable penetration into intertidal sediment, depending on substrate grain size -High potential for sinking after weathering and uptake of sediment -Generally removable from water surface when fresh -May form tar balls and tarry residue	-Acute and chronic toxicity in marine organisms likely to result from: 1) Mechanical or physical coverage - oil completely smothering organisms causing death 2) Chemical toxicity - results from the exposure to toxic aromatic fractions of the oil. 3) A combination of mechanical or physical coverage and chemical toxicity -Mechanical or physical smothering causes acute toxicity in many marine organisms and chronic toxicity in many marine plants.
Asphalt, Bunker C, No. 6 fuel oil, waste fuel	-Form tarry lumps at ambient temperatures -Non-spreading -Relatively non-toxic -May soften and flow when exposed to the sun -Difficult to recover from water surface with most cleanup equipment -Can be removed manually from beaches	-Acute and chronic toxicity occurs more from smothering effects than from chemical toxicity, due to the small proportion of toxic aromatic fractions found in heavy, residual oils -Toxicity may present a greater threat to marine plants and sedentary organisms than to mobile organisms

Reference: Exxon Oil Spill Response Field Manual

Table 5.4

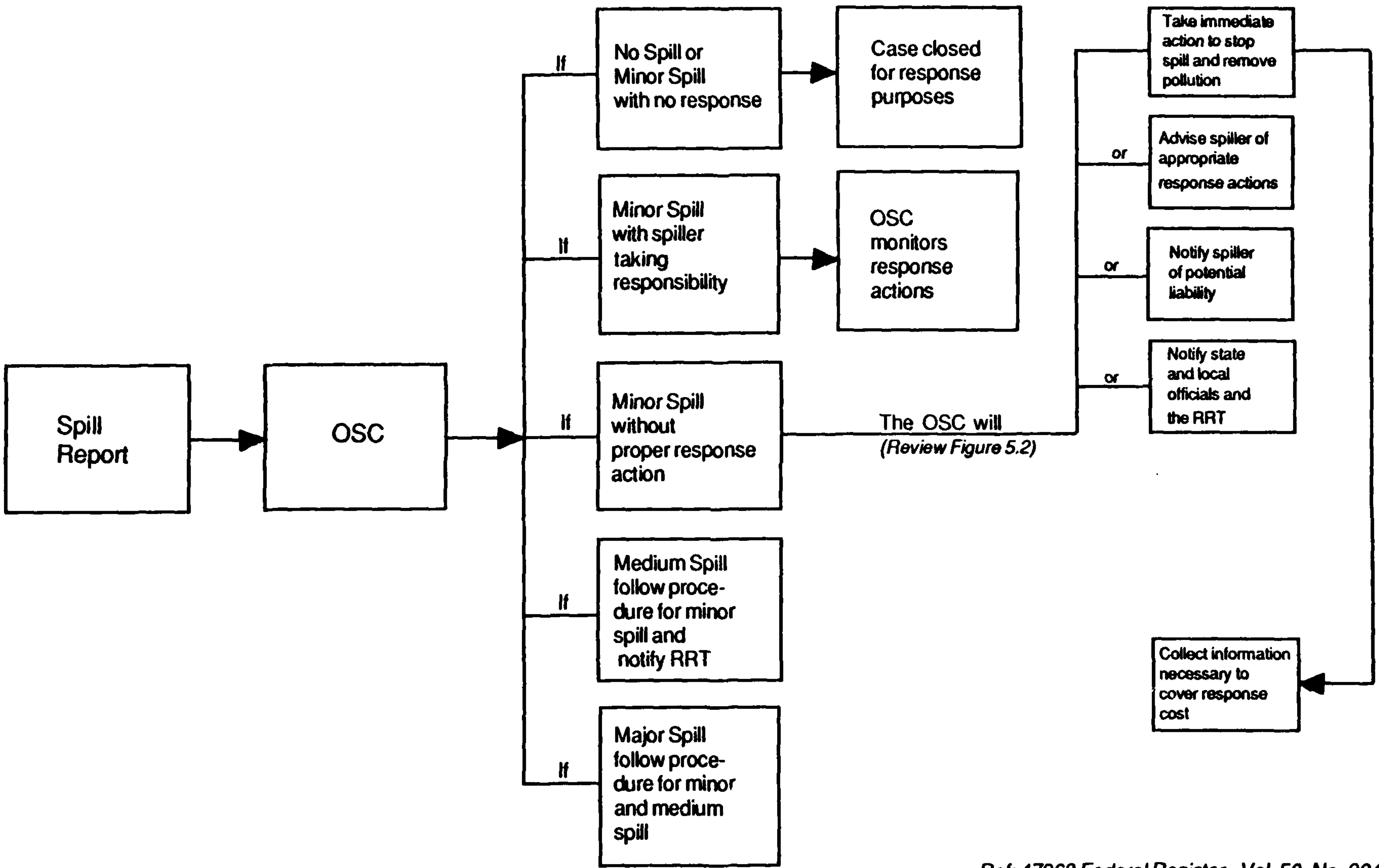
SUMMARY OF OIL SPILL RESPONSE TECHNIQUES

TECHNIQUES	ADVANTAGE	DISADVANTAGE
Mechanical Cleanup	o Excellent for winter spills o Good in calm water o Moderate in broken ice o Excellent for shorelines	o Not effective in dense, broken ice o Not effective in rough seas o Not effective during dense fog
In-Situ Burning	o Effective for fresh spills o Fire containment boom can make oil thick enough to burn (2-3 mm - mininum thickness) o May be only response for dense, broken ice	o Creates air pollution which could affect coastal villages o Leaves viscous residue on water surface o Not effective for weathered oil o Not effective for emulsified oil
Chemical Dispersants	o May be effective for some crude oils in temperate water	o May not be effective in cold water o Not effective for weathered or emulsified oil o Impact on Beaufort Sea wildlife is unknown o Not recommended for shallow near-shore waters

Table 5.5

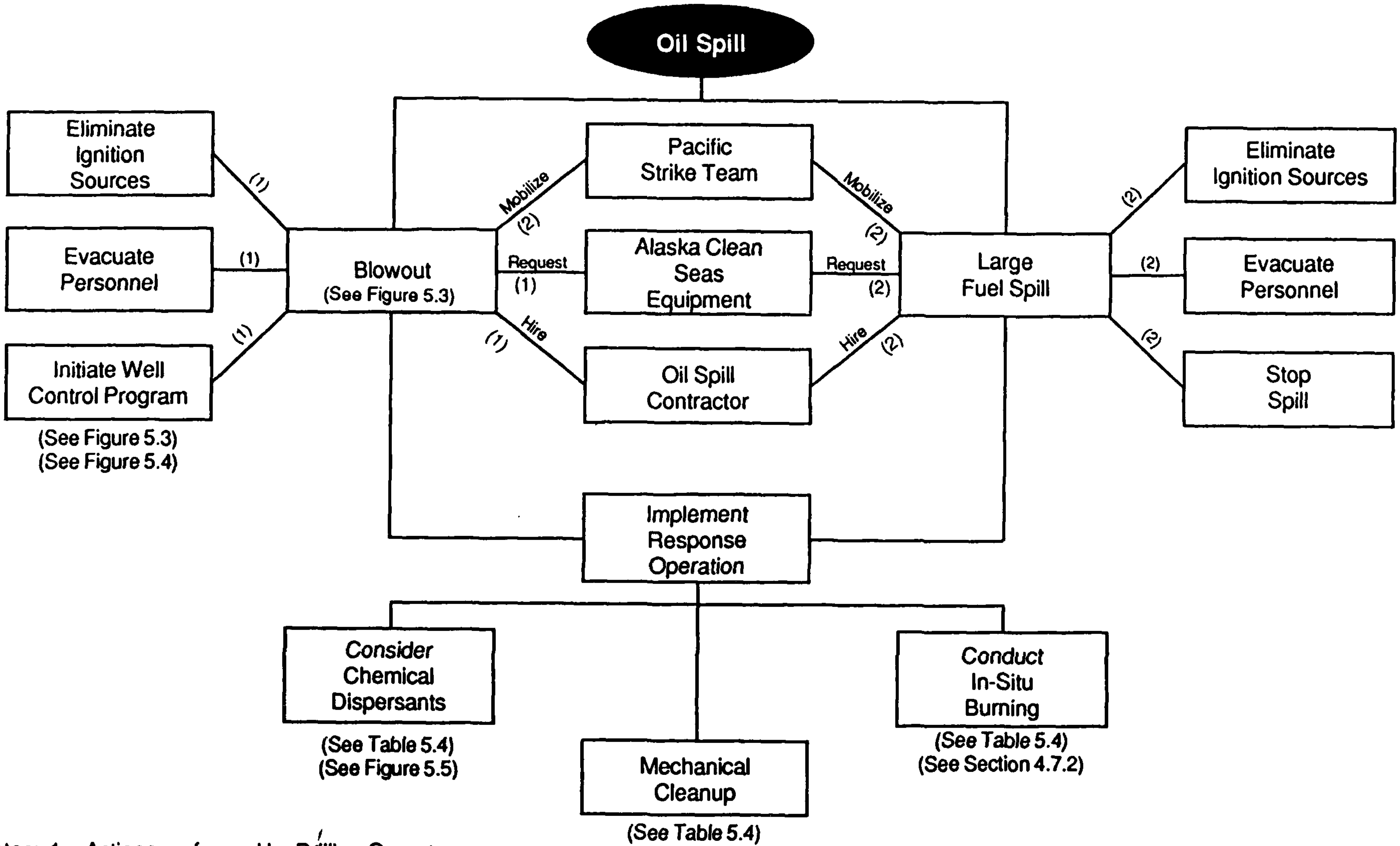
OIL SPILL RESPONSE PRIORITIES

- Stop and contain the spill at its source
- Monitor spill movement and protect sensitive shorelines
- Determine the extent of the spill via surveillance
- Deploy equipment for offshore cleanup
- Implement shoreline cleanup as required
- Restore the coastline to its pre-spill condition where possible
- Dispose of recovered oil and oil-contaminated material
- Prepare final report for oil spill



Ref: 47968 Federal Register - Vol. 50, No. 224

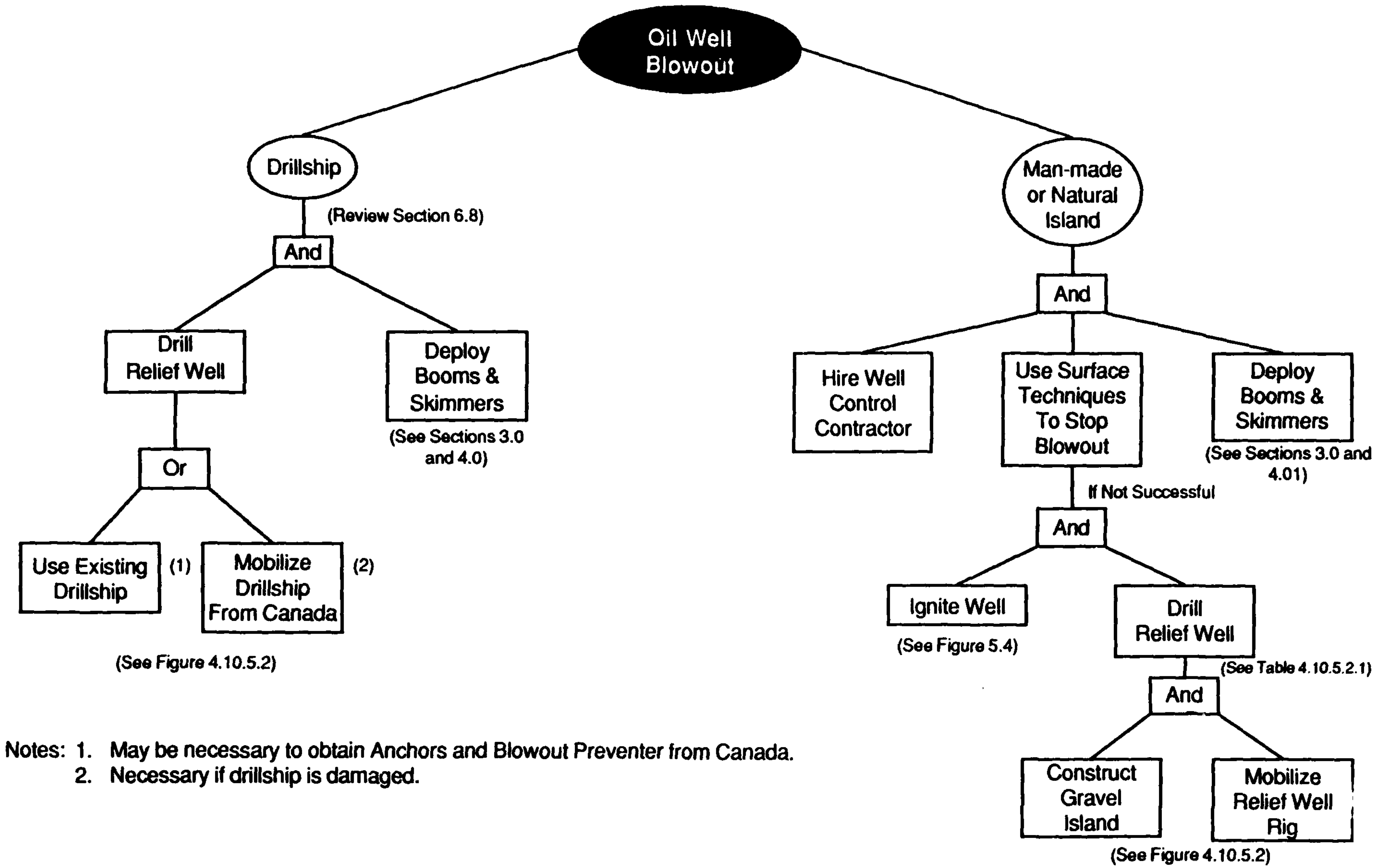
Figure 5.1 **ON-SCENE COORDINATOR RESPONSE CONSIDERATIONS**



Notes: 1. Actions performed by Drilling Operator.
2. Possible actions performed by OSC or Cleanup Contractor.

Figure 5.2

Oil Spill Response Actions



Notes: 1. May be necessary to obtain Anchors and Blowout Preventer from Canada.
2. Necessary if drillship is damaged.

Figure 5.3 — **Well Control For Blowouts**

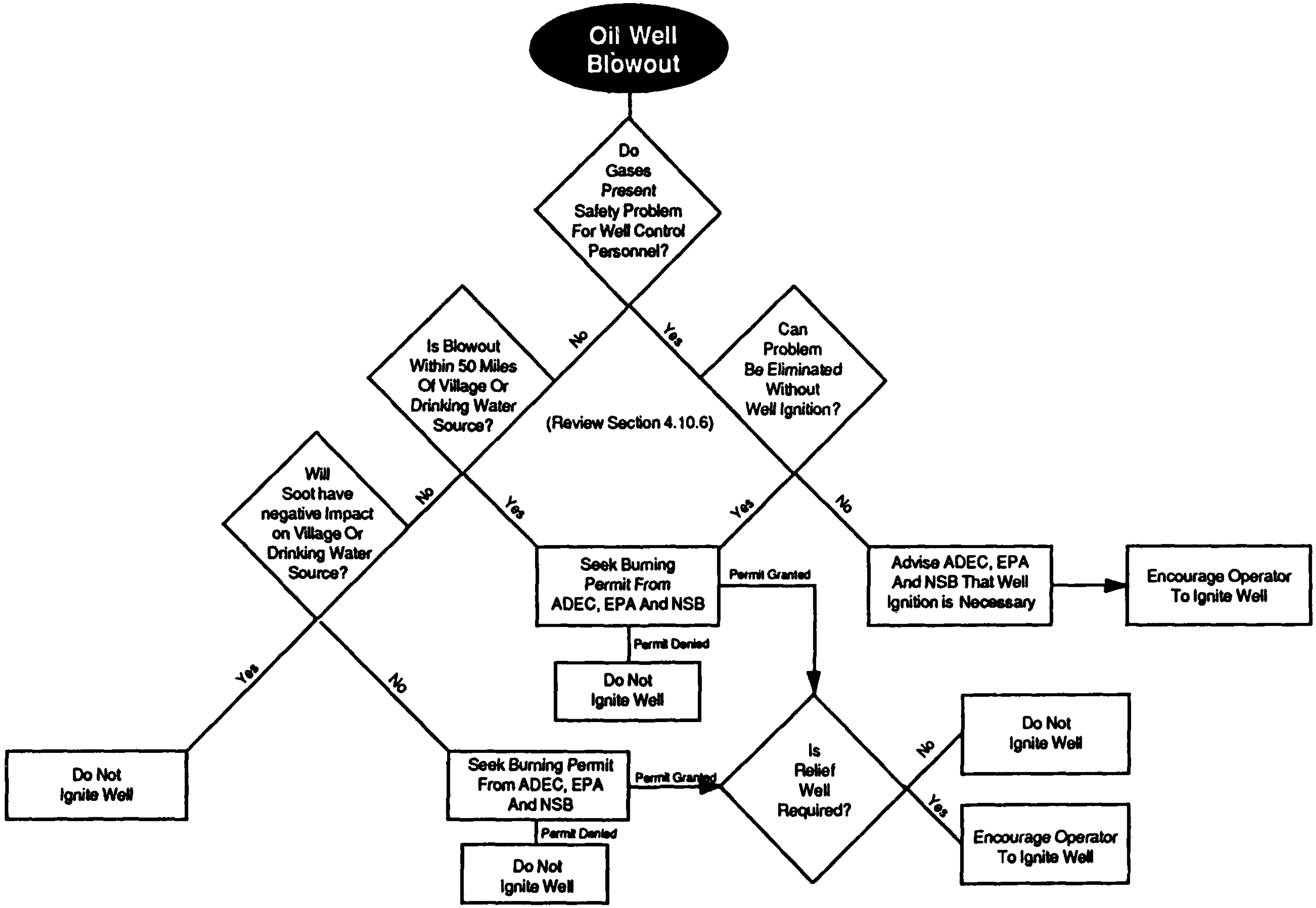


Figure 5.4

Well Ignition Decision

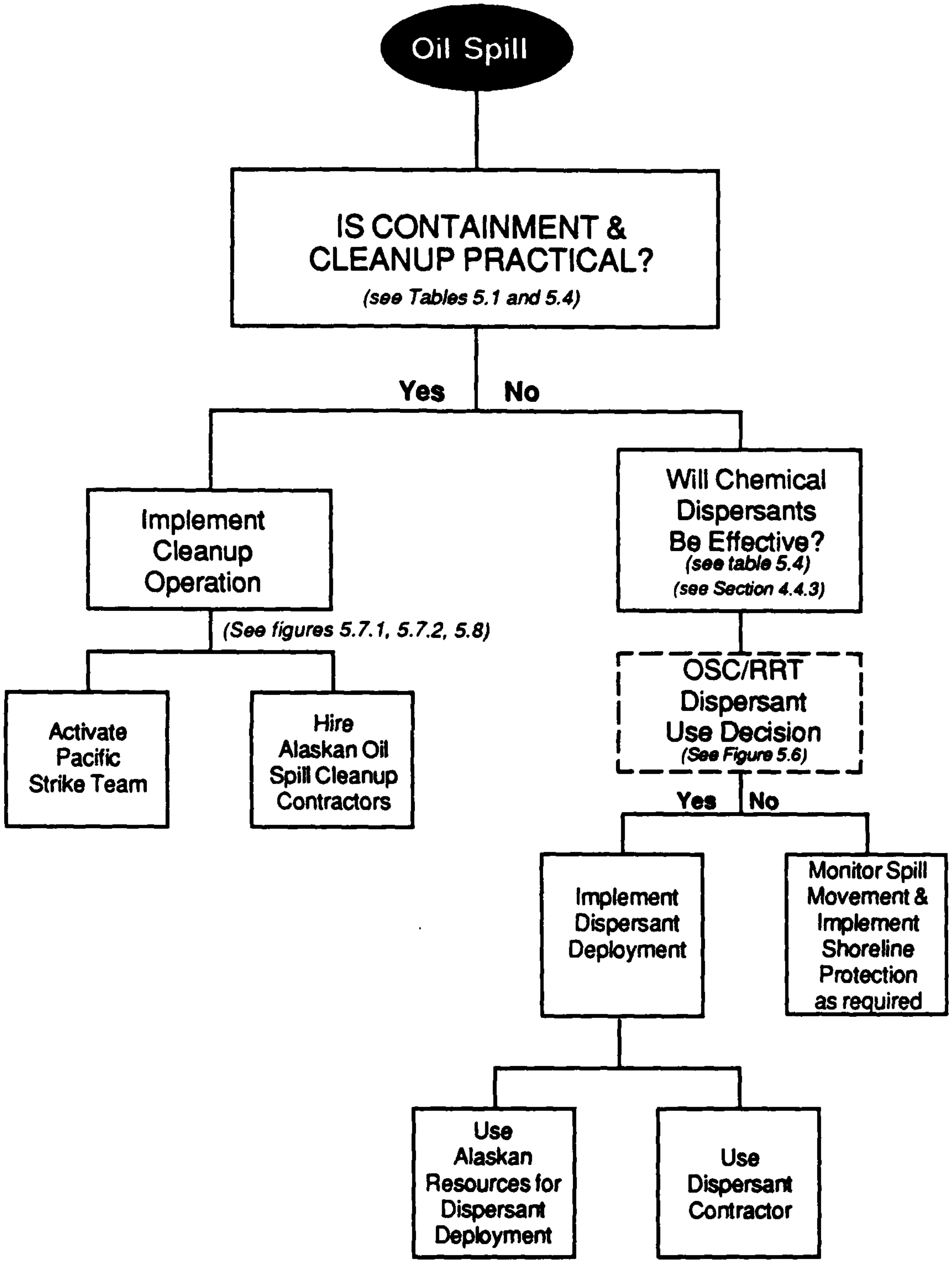
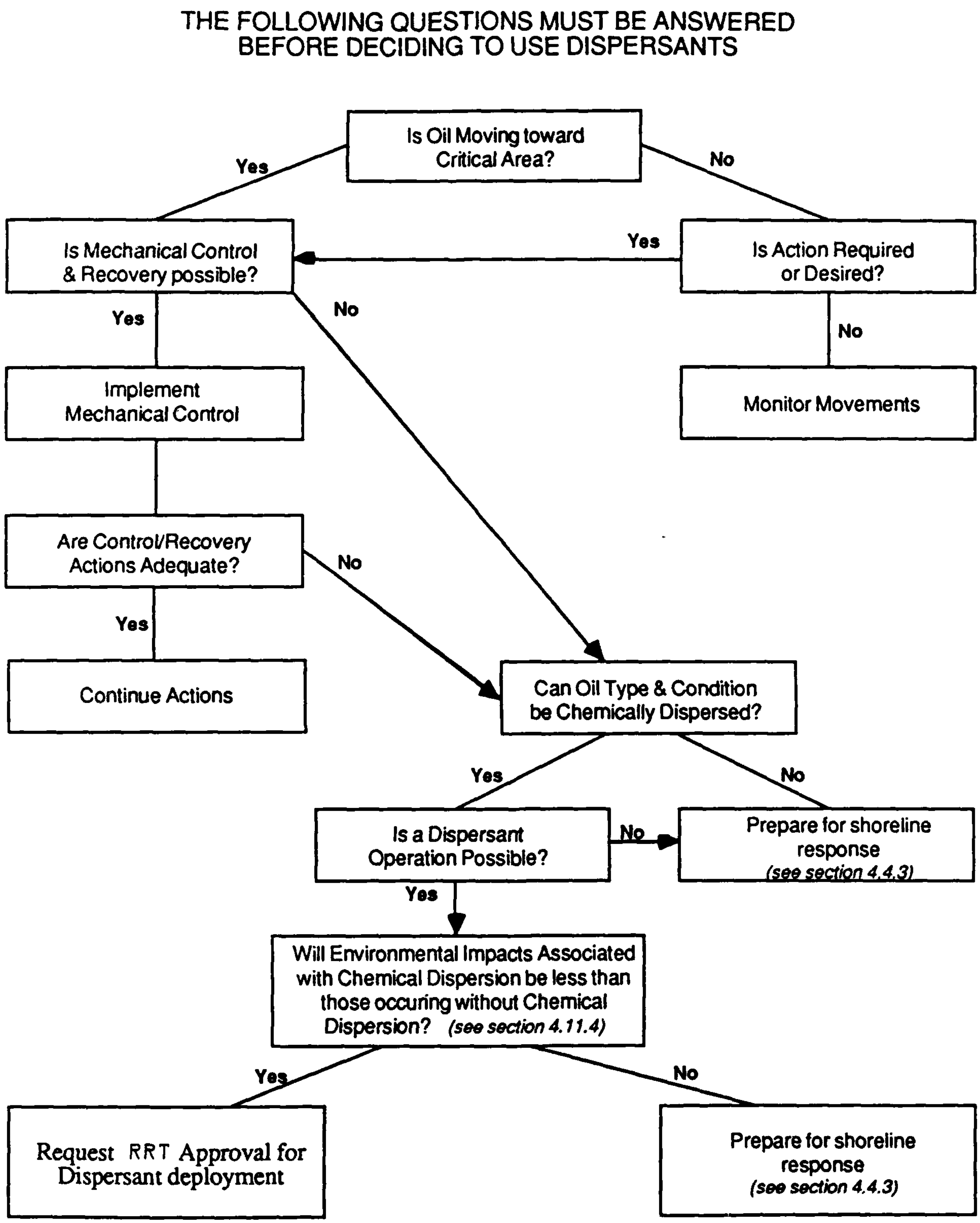


Figure 5.5

DISPERSANT USE DECISION TREE - A



NOTE: Immediate threat to life PRE-EMPTS this decision process.

Figure 5.6	**DISPERSANT USE DECISION TREE - B**

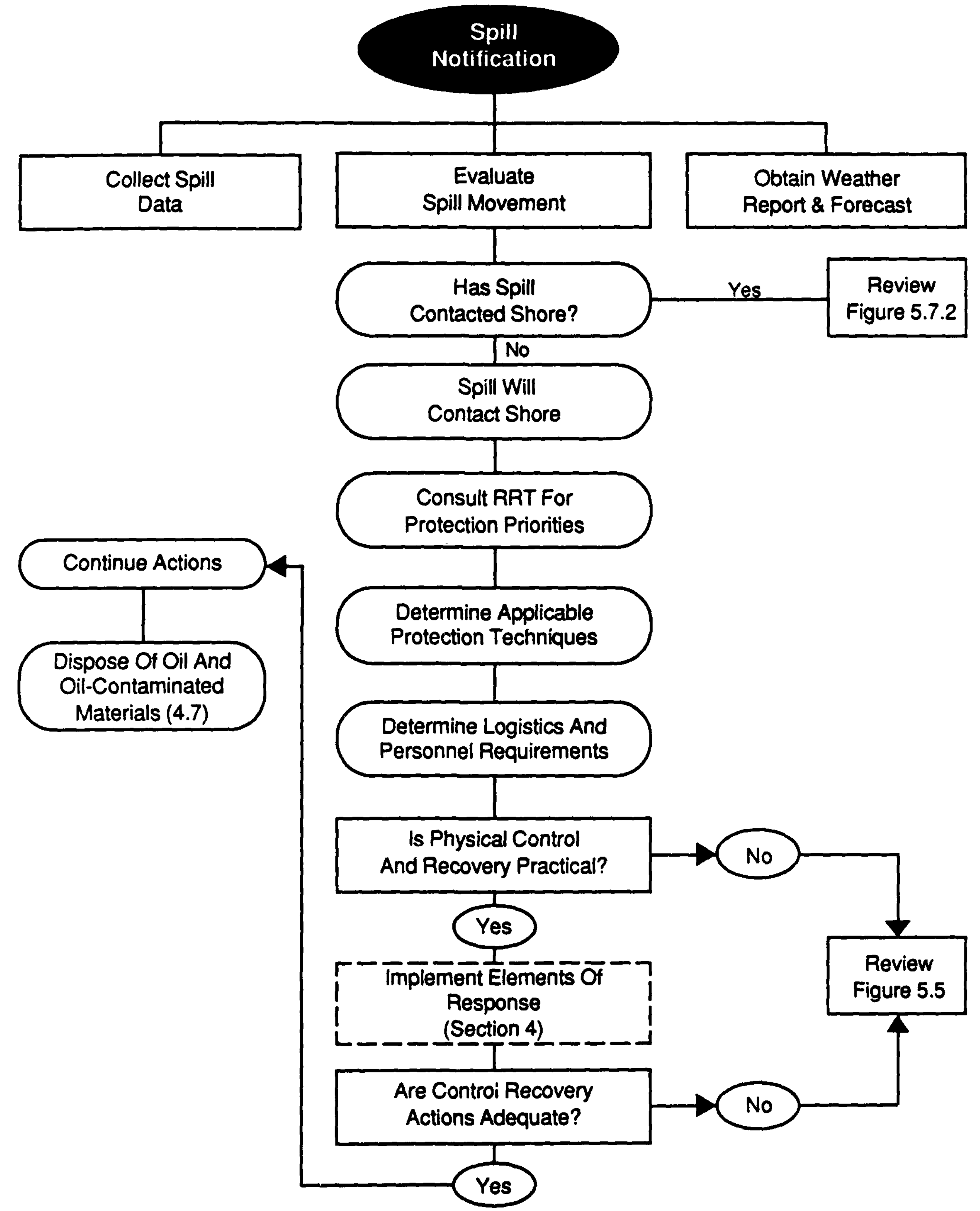


Figure 5.7.1	Shoreline Response Decision Tree - A

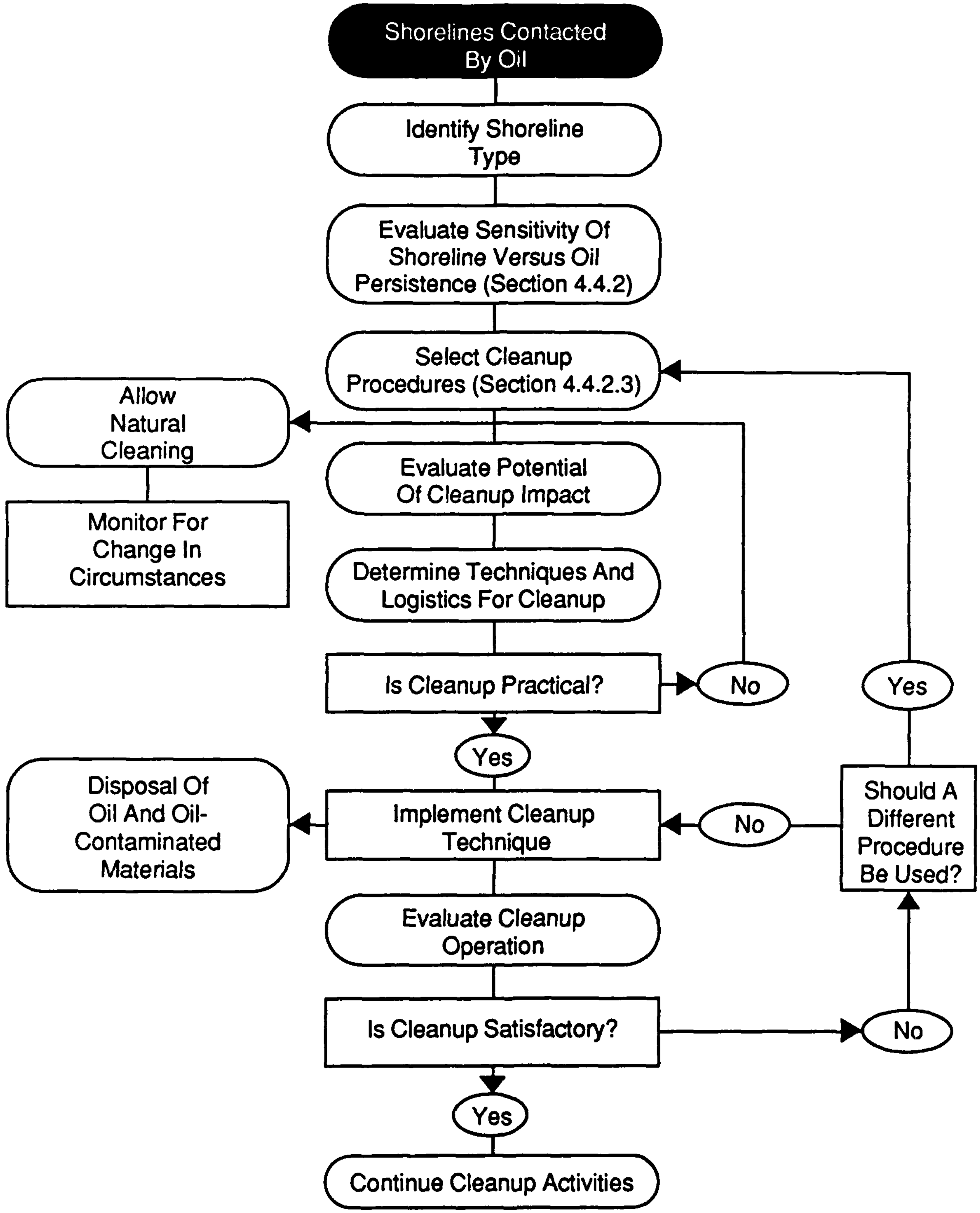
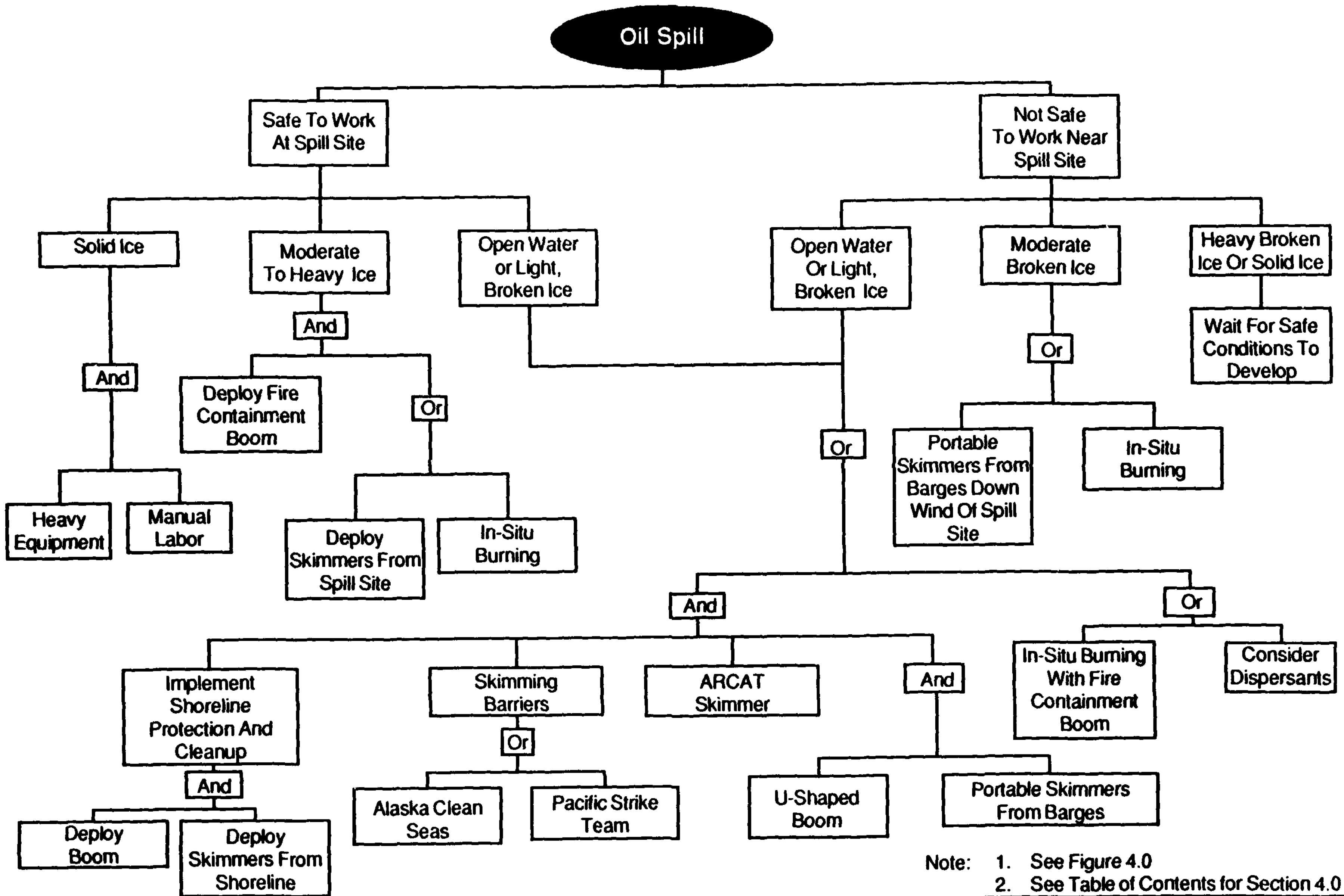


Figure 5.7.2	**Shoreline Response Decision Tree - B**



Note: 1. See Figure 4.0
2. See Table of Contents for Section 4.0

Figure 5.8 — **Beaufort Sea Oil Spill Countermeasures**

6.0 OIL SPILL RESPONSE SCENARIOS

6.1 Objective

This section includes seven scenarios which discuss response operations which could be implemented for major oil spills in the Beaufort Sea. The objective of these scenarios is to acquaint the On-Scene Coordinator (OSC) with equipment, techniques, considerations, and the decision process for responding to spills from petroleum related activities. This in turn will provide valuable insight regarding equipment deployment and resource allocation.

To ensure that the scenarios are as realistic as possible, they were developed by oil spill consultants who have a thorough understanding of the current technology for spill response in the Beaufort Sea. Also, to the extent possible, they were based on actual situations which have occurred in either the Alaskan or Canadian Beaufort Sea or the Gulf of Mexico.

While reviewing the scenarios it is important to recognize that they are hypothetical. Although the equipment and organizations actually exist, the response operations are nothing more than stories which depict a rational process for establishing priorities for cleaning up spills and protecting the environment. It should be understood that the priorities for a real spill will depend on the potential impact, environmental conditions, and effects that these conditions will have on the spill. While the scenarios are hypothetical, they highlight actual capabilities and limitations which may be encountered in Beaufort Sea response operations.

To enable the scenarios to serve as a training aids for the OSC, each one will provide the following information:

1. Spill location, source, and volume of oil released.

2. A summary of the environmental conditions existing when the spill occurred and during the response.

3. A synopsis of the oil movement along with a material balance showing how much is recovered by various cleanup techniques.

4. A discussion of the steps implemented by response personnel for spill monitoring, containment, recovery, and disposal.

5. An estimate of the time, manpower, and equipment required to control and clean up the spill.

6.2 Winter Blowout With Well Ignition

6.2.1 Description of Event

Shortly after 0700 hours on January 1st, a blowout occurred on a exploration well located in 50 feet of water approximately 11 miles north of Pogik Bay (Figure 6.2.1). The release was estimated at 5,000 barrels of oil per day (bopd) accompanied by 600 to 800 standard cubic feet (scf) of gas per barrel of oil.

Several hours after the blowout began, an explosion occurred and ignited the well. However, prior to ignition, approximately 1,000 Bbls of oil were released to the environment.

6.2.2 Environmental Conditions

When the blowout occurred, visibility was poor due to blowing snow and darkness. The ambient air temperature was -30°F and winds were gusting to 40 knots. Although the ice around the drilling site was 4 feet thick, it contained several cracks due to a lead which recently closed. The average snow cover range was five inches.

Weather conditions throughout the response operation are summarized in Figure 6.2.2. These conditions are based on historical weather conditions.

6.2.3 Spill Behavior

The blowout continued for 30 days and released 150,000 Bbls. of oil prior to being shut-in by surface techniques. Approximately 75% of the oil was consumed by combustion after the well was ignited. As a result, 37,500 Bbls of oil covered the snow and ice around the drilling site. In areas where thick layers of oil covered cracks in the ice, the weight of the oil forced some of it to go beneath the ice.

6.2.4 Response Actions

6.2.4.1 Immediate Response Actions

When the Operator recognized that a blowout was eminent, rig personnel were evacuated to a safe location upwind of the drilling site, and potential ignition sources were shutdown. Immediately afterwards, helicopters were mobilized from Deadhorse, Alaska to transport personnel to shore base facilities at Prudhoe Bay.

After the blowout occurred, the Operator notified the Alaska Department of Environmental Conservation, Minerals Management Service, National Response Center, North Slope Borough, and U.S. Coast Guard in Anchorage, Alaska. While these notifications were in progress, the Operator's Emergency Response Teams (ERT) for oil spill cleanup and well control were activited. ERT members

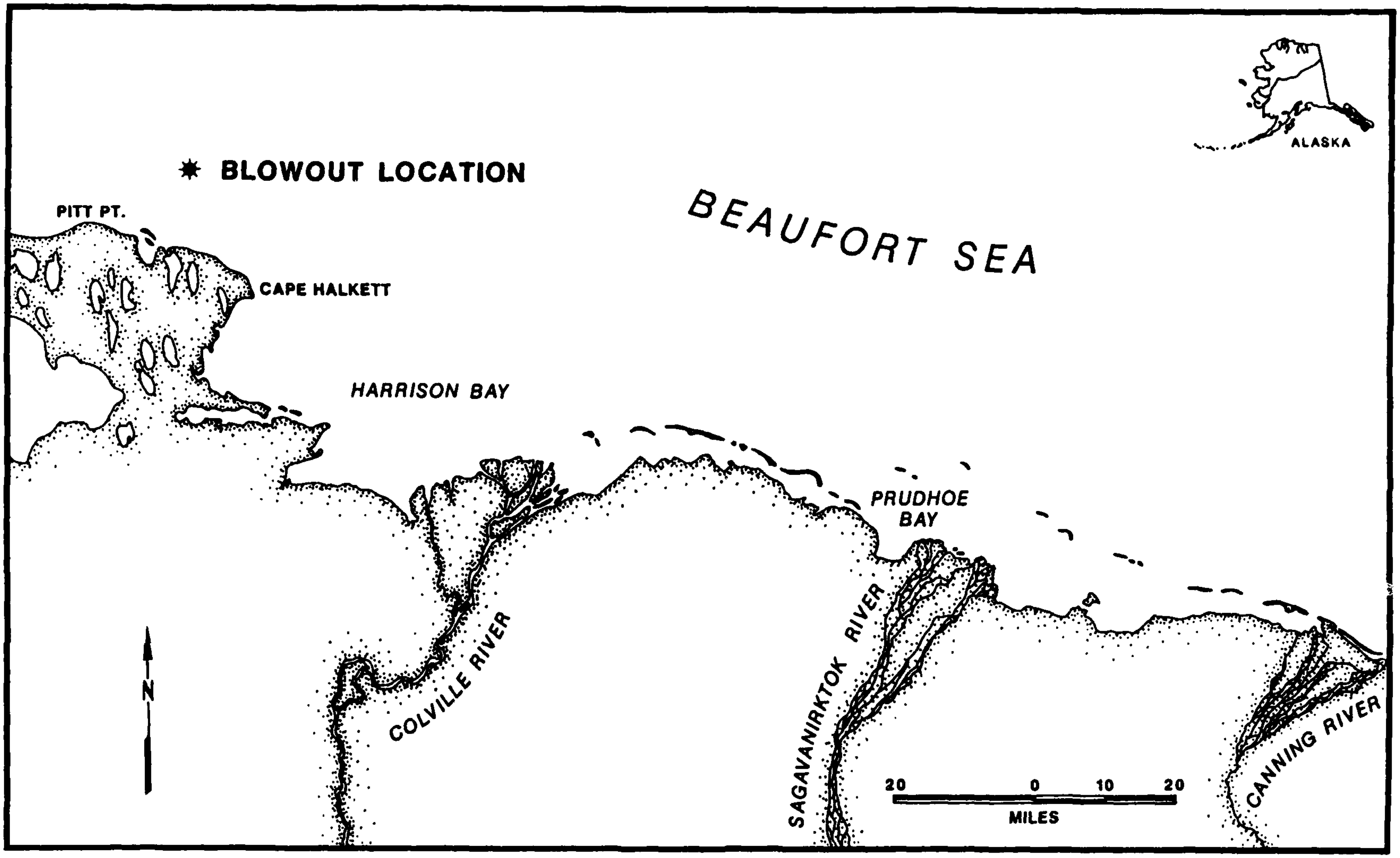
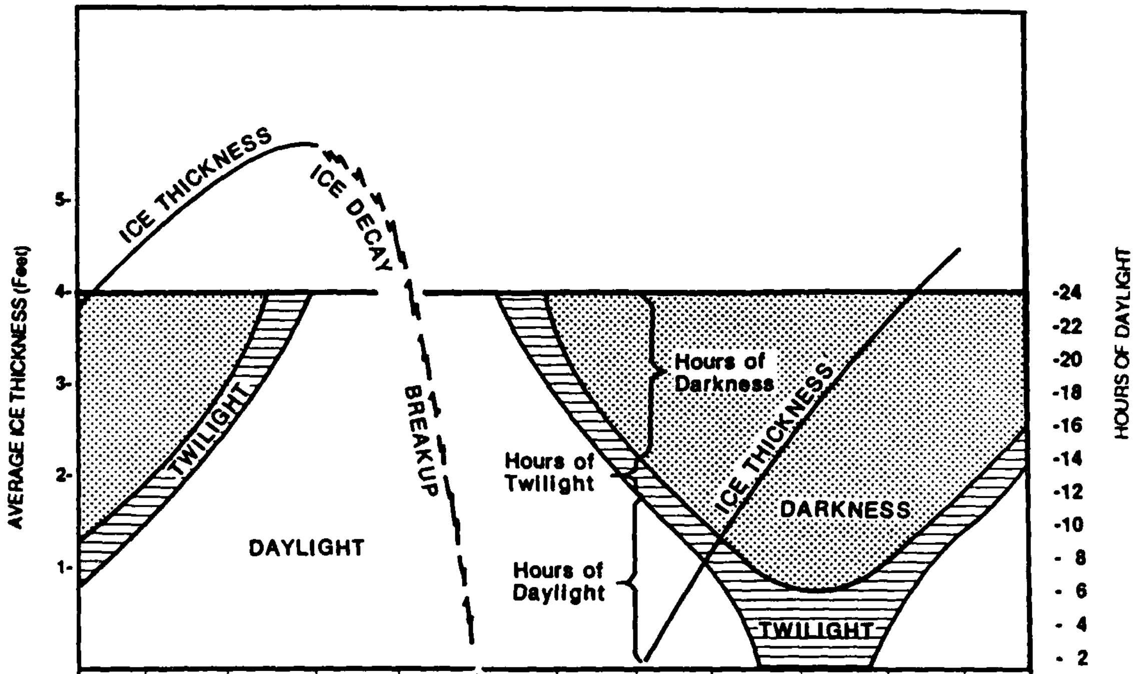


Figure 6.2.1 LOCATION OF WINTER BLOWOUT WITH WELL IGNITION



	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb
MEAN TEMP. (°F)	-13	-4	21	35	41	41	32	16	-7	-14	-16	-23
MEAN WIND SPEED (KTS)	10	9	9	9	9	10	11	11	12	10	11	10
PREVAILING WIND DIR.	ENE	WSW	E		ENE		E		ENE	ENE		WSW
CURRENTS (KTS)	Less than 0.1 kt				0.1 to 1.0 kt Primarily wind induced				Less than 0.1 kt			
CURRENTS PREV. DIR.	Primarily westward				Variable, wind incuded				Primarily westward			
NEW SNOW (IN.)	2.0	1.0	1.5	-	-	-	1.5	8.5	1.0	2.5	-	1.0
AVG. SNOW ON ICE (IN.)	Elongated drifts 1-2 ft. high separated by alternating troughs 3-4 ins. deep								Elongated drifts 6-12 ins. high w/ shallow troughs			
WATER DEPTH				40 ft. during open water, less when ice present								
WAVES						Generally calm with occasional wind chop						
VISIBILITY	Infrequent poor visibility due to blowing snow & fog			Visibility 6 mi. approximately 25% of the time due to fog			Infrequent poor visibility due to fog			Poor visibility due to blowing snow about 15% of the time		

Figure 6.2.2

SUMMARY OF ENVIRONMENTAL DATA FOR THE BEAUFORT SEA AREA

who were out of town were directed to return to Anchorage, Alaska within 24 hours.

Following the Coast Guard notification, the On-Scene Coordinator (OSC) alerted the Pacific Area Strike Team and advised the Alaska Regional Response Team that their support may be required. The OSC also requested a meeting with the Operator to discuss plans for stopping the blowout and cleaning up the spill. Prior to this meeting, the OSC notified the National Oceanic and Atmospheric Administration (NOAA) and requested the Scientific Support Coordinator to perform a spill impact assessment.

Once notified, the ERT immediately performed the following activities:

- The ABSORB warehouse staff (Prudhoe Bay) was requested to prepare portable shelters, heaters, lights, and response boxes for mobilization to the spill site by helicopter.
- Alaska Clean Seas' permission was requested to use the ABSORB warehouse as base camp for the response operation.
- ERA Aviation and Evergreen Helicopters were advised that their aircraft at Deadhorse would be required to support the response operation.
- North Slope contractors (VECO, Inc., GSL, Frontier Equipment Co., and Arctic Rentals) were requested to provide trucks and heavy equipment as required for cleaning up oiled snow and ice.
- MarkAir was notified that a jet would be needed to transport the ERT from Anchorage to Deadhorse.
- A Well Control Contractor in Texas was requested to report to Prudhoe Bay.

6.2.4.2 Response Planning

At 1100 hours on January 1st a meeting was held at the Operator's Office in Anchorage, Alaska to establish priorities for the response operation. The OSC was invited to this meeting and advised that the Operator would assume the responsibility for the blowout and deploy all resources necessary to minimize its impact on the environment.

During the meeting, the Operator stated that well control experts from Texas would use surface techniques to shut the well in, and heavy equipment would be used to clean up the oiled snow. Since the well was burning, up to 75% of the oil would be consumed by combustion. As a result, the cleanup operation could be rapidly completed after the blowout was stopped.

The OSC questioned whether it would be appropriate to begin a relief well and asked if it would be possible to use surface control techniques on a burning well. The ERT stated that 30 to 45 days would be required to complete a relief well and kill the blowout. Historically, most blowouts were terminated by surface techniques or stopped due to reservoir depletion or well bridging. Previous experience suggests that one of these actions would probably stop the blowout in a few days.

With respect to using surface techniques for well control, was the OSC was advised that when all of the necessary equipment in in place, the well control experts would use explosives to extinguish the fire. Immediately afterwards, the well would be capped.

At 1400 hours, the ERT and OSC departed for Deadhorse by chartered aircraft. Prior to departing, the OSC placed the Pacific Area Strike Team on standby and notified the Alaska Regional Response Team that further information on the blowout would be provided as soon as it was available. The ERT and OSC arrived at Deadhorse at 1530 hours. However, adverse weather conditions prevented them from traveling to the spill site.

6.2.4.3 Spill Monitoring and Deployment

Whiteout conditions at the drilling site and poor weather conditions at Prudhoe Bay prevented response activities for five days. On January 6, the weather improved. The OSC along with the Operator and Well Control Contractor departed by helicopter to perform aerial surveillance of the drill site.

The helicopter approached the upwind side of the burning well. By using binoculars and flood lights on the helicopter, the OSC and Well Control Contractor discovered that the surface casing was still in place. Although the rig was badly damaged, most of the equipment in the rig cellar appeared to be in good shape. This confirmed that surface control techniques would be the best option for stopping the blowout.

Surveillance of the area around the drill site revealed that a large pool of thick oil covered the ice on the downwind side of the gravel island. Also, for several miles downwind of the gravel island, the ice was covered with soot and fallout from the smoke plume. Since winds near the drilling site had changed direction several times during the previous days, it was assumed that fallout also accumulated on the upwind side of the island but was covered by blowing snow.

6.2.4.4 Equipment Mobilization and Deployment

On January 6, a ground convoy containing portable living quarters, well control equipment and cleanup equipment departed

Prudhoe Bay for the drill site. From Prudhoe Bay the convoy traveled over a gravel road to Oliktok Point. From there, it used an existing ice road to reach Cape Halkett where a field camp was set up. An ice road was used to access the drilling site from Cape Halkett.

The ground convoy reached Cape Halkitt about 10 hours after departing Prudhoe Bay. Approximately one hour later, contract personnel arrived by helicopter and set up the field camp. Later that day, weather reports indicated that winds up to 40 knots were likely to occur within 3 hours. In view of this, all personnel returned to Prudhoe Bay by helicopter. Throughout the response operation, field personnel were evacuated to Prudhoe Bay when high winds were forecasted.

Since low temperatures and snow prevented the oil which escaped the burning well from spreading more than a few yards from the gravel island, the OSC and Operator agreed to delay the cleanup operation until the well was capped. Their objective was to avoid needlessly exposing the cleanup crew to fallout and aromatic hydrocarbons created by the burning well.

6.2.4.5 Blowout Termination

On January 10, the Well Control Contractor began work to stop the blowout. Due to equipment failure and personnel evacuations necessitated by poor weather conditions, this effort was aborted several times. On January 31, the well was successfully capped.

6.2.4.6 Cleanup Operation

On February 1, the cleanup operation began. Front-end loaders were used to place oiled snow and ice in dump trucks. In several areas, graders were used to scrape the ice to ensure that all of the oil was removed and sheens would not be created during breakup. Light for the cleanup operation was provided by portable equipment obtained from the ABSORB warehouse. Vehicle headlights were also used.

The dump trucks were emptied into 3 feet deep ice pits which were constructed in shorefast ice. After a burn permit was obtained from the Alaska Department of Environmental Conservation and approval was granted by the North Slope Borough and EPA, the recovered oil was ignited. To maximize combustion efficiency and reduce air pollution, water and air were fed to the center of the pit through spargers which were installed prior to ignition.

Divers used high intensity lanterns to locate oil under ice. As the light was directed through the ice, it decreased in areas where oil existed. Ice augers and ditch witches were used to cut holes in the ice so that the oil could be recovered by vacuum skimmers. It was estimated that 80 to 90 percent of the oil under the ice was recovered. This oil was also placed in the ice pits and burned.

6.2.5 Conclusion

The blowout lasted for 30 days and discharged 150,000 barrels of oil. Approximately, 75 percent of the oil was burned at the well head and 25 percent (37,500 barrels) flowed off the gravel island onto the surrounding ice.

A total of 100 persons were used during the response operation. From February 1 through February 20, the cleanup activity required two 25-person shifts. When weather permitted, each shift worked 6 hours. Five front-end loaders, two graders, and ten dump trucks were required. The loaders, graders, and portable living quarters were transported to the field camp on low-boys.

The cleanup operation was completed on February 28. All of the oil and fallout on the ice was recovered. About 80 to 90 percent of the oil under the ice was removed. The recovered oil was burned in ice pits. The burn residue and fallout were placed in DOT approved drums and shipped to an EPA approved disposal facility in the Lower-48.

Within 15 days after the cleanup was completed, the OSC forwarded a report on the blowout and operation to the National Response Center.

6.3 Winter Blowout Without Well Ignition

6.3.1 Description of Event

At 0100 hrs on April 30th, an exploration well located in 7 feet of water approximately 3 miles offshore in Harrison Bay (Figure 6.3.1) blew out of control. The release was estimated at 5,000 Bbls of emulsified oil per day (bopd) accompanied by 600 to 800 standard cubic feet (scf) of gas per barrel of fluid.

When the blowout occurred, the rig was badly damaged. The surface casing and casing head were ejected from the well.

6.3.2 Environmental Conditions

When the blowout occurred, shorefast ice along the mainland coastline was beginning to thaw and signs of breakup were beginning in the Colville River. Further offshore, several leads were opening. Temperatures ranged from 25°F to 32°F. Winds were predominately out of the west gusting at speeds up to 25 knots. Weather conditions throughout the response operation are summarized in Figure 6.3.2. These conditions are based on historic weather conditions for the Beaufort Sea.

6.3.3 Spill Behavior

The initial release (5,000 bopd) decreased to 2,000 bopd over a 30-day period. Afterwards, it continued at this rate until the

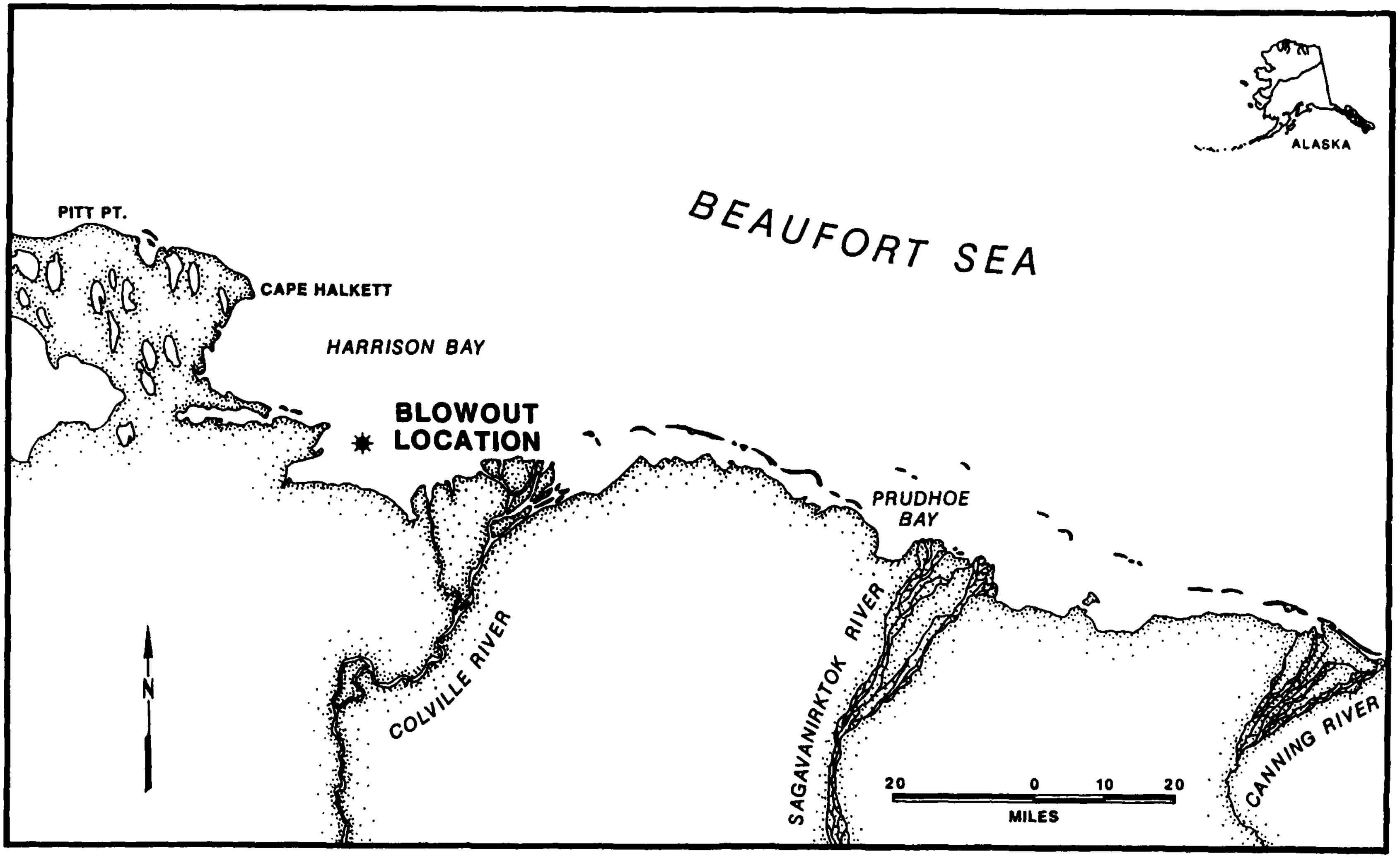
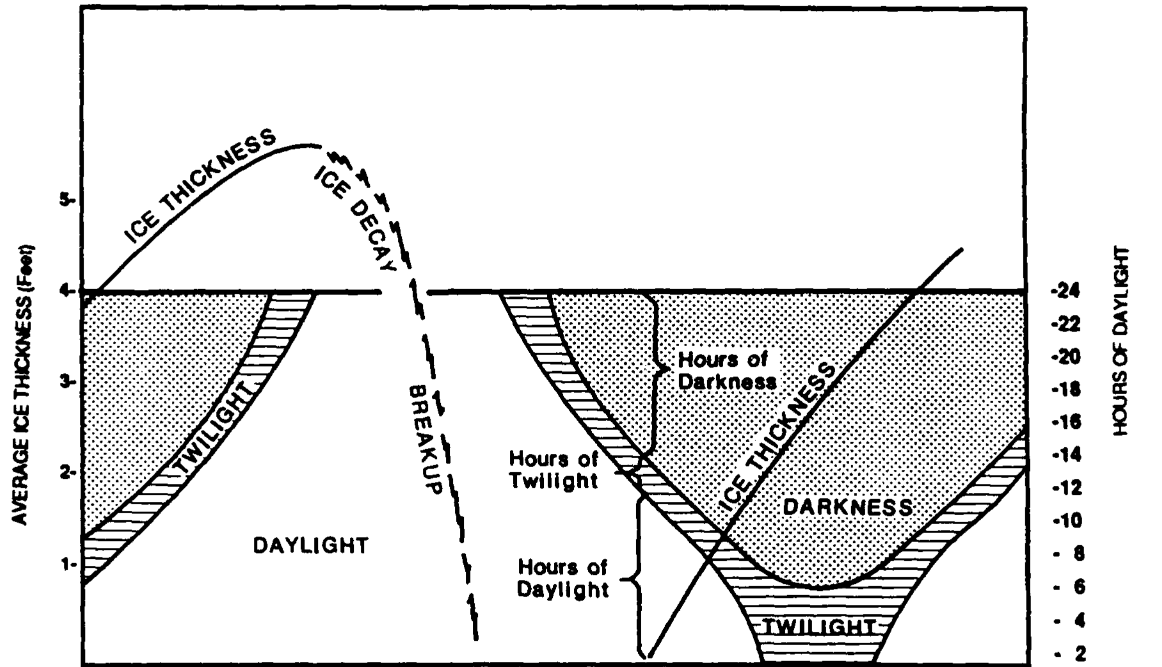


Figure 6.3.1

LOCATION OF WINTER BLOWOUT



	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb
MEAN TEMP. (°F)	-13	-4	21	35	41	41	32	16	-7	-14	-16	-23
MEAN WIND SPEED (KTS)	10	9	9	9	9	10	11	11	12	10	11	10
PREVAILING WIND DIR.	ENE	WSW	E		ENE		E		ENE	ENE		WSW
CURRENTS (KTS)	Less than 0.1 kt				0.1 to 1.0 kt Primarily wind induced				Less than 0.1 kt			
CURRENTS PREV. DIR.	Primarily westward				Variable, wind incuded				Primarily westward			
NEW SNOW (IN.)	2.0	1.0	1.5	-	-	-	1.5	8.5	1.0	2.5	-	1.0
AVG. SNOW ON ICE (IN.)	Elongated drifts 1-2 ft. high separated by alternating troughs 3-4 ins. deep								Elongated drifts 6-12 ins. high w/ shallow troughs			
WATER DEPTH				40 ft. during open water, less when ice present								
WAVES						Generally calm with occasional wind chop						
VISIBILITY	Infrequent poor visibility due to blowing snow & fog			Visibility 6 mi. approximately 25% of the time due to fog			Infrequent poor visibility due to fog			Poor visibility due to blowing snow about 15% of the time		

Figure 6.3.2

SUMMARY OF ENVIRONMENTAL DATA FOR THE BEAUFORT SEA AREA

well was shut-in during October. Approximately 305,000 Bbls of emulsified oil were released during the blowout. From April 30th through early July, ice restricted spreading and contained the oil near the drilling site. As warmer temperatures prevailed, the ice melted and wind caused the spill to spread.

6.3.4 Response Actions

6.3.4.1 Immediate Response Actions

When the rig instruments indicated that abnormal downhole pressures were developing, all personnel except the Well Control Crew were evacuated to shore facilities at Prudhoe Bay. When it became apparent that equipment problems would not allow the well pressure to be controlled, the remaining personnel were evacuated by helicopters which were on standby near the gravel island.

After the blowout occurred, the Operator notified the Alaska Department of Environmental Conservation, Minerals Management Service, National Response Center, North Slope Borough, and the U.S. Coast Guard in Anchorage, Alaska. While these notifications were in progress, the Operator's Emergency Response Teams (ERT) for oil spill cleanup and well control were activited.

The On-Scene Coordinator (OSC) requested a meeting with the Operator to discuss plans for stopping the blowout and cleaning up the spill. The Operator assumed full responsibility for the spill and invited the OSC to attend a meeting in Anchorage, Alaska at 1200 hours to discuss the response operation.

The OSC alerted the Pacific Area Strike Team and notified the Alaska Regional Response Team Chairman that their support may be needed. Following this, the OSC contacted NOAA and requested that the Scientific Support Coordinator report to the Regional Response Center in Anchorage.

Once notified, the Operator's ERT immediately performed the following activities:

- The ABSORB warehouse staff (Prudhoe Bay) was requested to prepare portable shelters, heaters, lights, and response boxes for mobilization to the spill site by helicopter.

- Alaska Clean Seas' permission was requested to use the ABSORB warehouse as base camp for the response operation.

- ERA and Evergreen were advised that their aircraft at Deadhorse would be required to support the response operation.

- North Slope contractors were requested to provide trucks and heavy equipment for cleaning up oiled snow ice.

- MarkAir was notified that a jet would be needed to transport the ERT from Anchorage to Deadhorse.
- A Well Control Contractor in Texas was requested to report to the Operator's facilities in Prudhoe Bay within 24 hours.
- Oil Spill Cleanup Contractors in Anchorage were requested to meet at the ABSORB warehouse and prepare for the cleanup operation.

6.3.4.2 Response Planning

Several hours after the ERT was activated, a meeting was held at the Operator's facility in Anchorage to establish priorities for the response operation. The OSC was advised that Well Control Experts from Texas would attempt to shut the well in with surface techniques. Based on the effectiveness of these techniques in other areas, it was estimated that the blowout could be terminated within several days. Since the gravel island was surrounded by solid ice, front-end loaders and other heavy equipment would be used to clean up the spill.

During this meeting the Operator received a damage report from the Rig Supervisor. It was reported that the rig was badly damaged and the casing had been ejected from the well. The ice around the gravel island was covered with a thick brown fluid. Winds at the drilling site were 25 to 30 knots. This dispersed the gases released by the blowout and minimized the potential for an explosion. It was unknown whether gases released by the blowout contained hydrogen sulfide.

The OSC questioned whether it would be appropriate to begin a relief well and if the blowout should be ignited. The Operator stated that the decision to drill a relief would be ruled out until the Well Control Contractor had inspected the rig and assessed the potential for shut-in by surface techniques. The reason for this is that up to 177 days would be required to complete a relief well. This includes 130 days to build a gravel island, 10 days to mobilize a rig, 30 days to drill the relief well, and up to 7 days to kill the blowout. Therefore, delaying the relief well decision for a few days would not have a significant impact on the events which may occur.

Since the oil was being contained by the ice surrounding the gravel island, it was agreed that the well would be ignited only if:

- The well was releasing toxic gases in harmful quantities, or
- The blowout could not be stopped by surface control techniques.

The reason for this is that the smoke from a burning well could exceed the ambient air quality standards established by the Clean Air Act and the products of combustion (soot and polynuclear aromatic hydrocarbons) could have a negative impact on coastal residents and the Arctic food chain.

At 1300 hours on May 1st, the OSC and the Operator's ERT departed for Deadhorse by chartered aircraft. At 1430, they arrived at Deadhorse and proceeded by helicopter to survey the blowout.

6.3.4.3 Decision to Ignite the Well

On May 2nd, the Well Control Contractor inspected the rig equipment and determined that surface techniques could not be used to stop the blowout. As a result, the Operator ordered the ERT to ignite the blowout and implement procedures for completing a relief well.

On May 3rd, incendiary devices with a time delayed ignition were attached to the rig equipment. Although a fireball was created when the these devices were detonated, the well did not ignite. For several days a number of techniques were tried for igniting the well. None of them were successful.

Attempts were also made to ignite the oil which pooled on the ice around the gravel island. Since this oil was emulsified with water, these attempts also failed.

6.3.5 Response Operation

6.3.5.1 Cleanup During Winter

By May 6th, it became apparent that heavy equipment was the only option for cleaning up the oil prior to breakup. Front-end loaders were used to mix the oil with snow. Once the oil was absorbed by the snow, it was placed in dump trucks and taken to lined pits which were constructed near Oliktok Point. When the snow melted, the emulsified oil was skimmed off and fed to a flare burner which burned it without creating black smoke.

Throughout May, this technique was used to clean up and dispose of the oil released by the blowout. To prevent personnel from being exposed to gases released by the well, cleanup was always conducted on the upwind side of the gravel island. As the wind direction changed, the position of the cleanup operation also changed. Explosimeters were used to monitor the gas concentration. Whenever this concentration reached 50 percent of the lower explosive limit 100 yards from the well, the cleanup operation was suspended and the personnel evacuated. This procedure was also implemented if the wind speed dropped below 5 knots.

6.3.5.2 Cleanup During Breakup and Open Water

During late May, Oil Spill Cleanup Contractors prepared ice-strengthened barges for deployment. Three barges were equipped with rope mop skimmers, Trans-Vacs, recovered oil storage containers, transfer pumps, living quarters, and a helicopter pad. Afterwards, the Cleanup Contractors began to familiarize contract personnel with the response equipment on the barges.

During mid-June, breakup occurred between Prudhoe Bay and Harrison Bay. Following this, the barges with the cleanup crews departed for the spill site. Each barge was pulled by an ice-strengthened tug at speeds ranging from 1 to 5 knots, depending on ice conditions.

Within 36 hours after departure, the response barges began to encounter oil on the water surface. Rope mop skimmers were deployed from the barges to clean up oil between ice floes. To prevent the rope mops from being torn by moving ice, it was necessary to frequently remove them from the water so that the ice could pass. As a result, this proved to be very tedious and the rope mops were not effective in areas containing more than 50 percent broken ice. Regardless of the ice concentration, it was found that rope mops could not effectively clean up emulsified oil. Therefore, hand-held weir skimmers and the Trans-Vacs were used when thick pools of emulsified oil were encountered.

The fluid recovered by the weir skimmers and Trans-Vacs was placed in storage containers (Baker Tanks) on the decks of the response barges. When each container was filled, it was allowed to set for several hours so that phase separation would occur. Afterwards, water was drained and returned to the sea. Following this, additional recovered fluid was placed in the storage container and this procedure was repeated until it was filled with emulsion. Afterwards, the storage containers were taken to shore where the contents were fed to a flare burner for disposal.

From mid-June through late September, each response barge recovered 200 to 300 barrels of emulsion per day. On several occasions, the cleanup operation was stopped by dense fog and storms. Although ice concentrations ranged from 25 to 95 percent from mid-June to late July, it did not stop the cleanup operation. The tug boats were able to maneuver the barges so that the cleanup equipment could have maximum exposure to the spill.

In late July, the ARCAT Skimmer was deployed. When ice conditions permitted, it was used in conjunction with a V-shaped boom. While operating in this mode, emulsified oil was recovered by the ARCAT's rear-mounted weir skimmer. However, recovery rates were limited by the ARCAT's 180-Bbl. internal storage capacity.

While the barges and ARCAT Skimmer were effective in water depths greater than 7 feet, many areas in Harrison Bay were too shallow

for them to enter. In some locations, personnel in small workboats were able to use portable weir skimmers to clean up portions of the slick in shallow water. When this occurred, the portable skimmers were attached to vacuum systems mounted on barges moored in deeper water.

As soon as the ice conditions allowed, a U.S. Coast Guard Skimming Barrier was mobilized from the Pacific Strike Team base at Hamilton Air Field, California and deployed downwind on the leeward side of the gravel island. Each end of the barrier was held in position by an ice-strengthened tug boat and the recovered fluid was transferred to storage tanks on a response barge. Both the skimming barrier's hydraulic power pack and pump float were mounted on this barge. This technique proved to be very effective because:

- o Most of the oil escaping the island was collected by the skimming barrier.

- o The tugs and barge could easily reposition the skimming barrier as the wind direction changed.

- o A crane on the barge could rapidly remove the skimming barrier from the water when storms developed or heavy ice encroached.

6.3.5.3 Shoreline Cleanup

Shoreline areas were placed into two categories: 1) those where natural forces such as wave action or erosion would eventually remove oil that contacted it, and 2) those where stranded oil would remain if no countermeasures were implemented. The latter was identified as having a higher sensitivity due to frequent use by migratory fowl during the summer. As a result, they were given the highest priority for protection. Input was requested from the Alaska Regional Response Team (RRT) to ensure that the correct priorities were established. Where possible, boom was deployed for shoreline protection.

Priorities and techniques for onshore cleanup were carefully coordinated with state and federal agencies. For sensitive areas where cleanup operations would do more damage to the environment than the oil, it was mutually determined by the RRT, OSC and Operator that no action would be taken. Appropriate steps recommended by state and federal agencies were used to protect migratory fowl from contact with areas that contained oil. In most cases, this entailed the use of scare-away cannons obtained from the ABSORB warehouse.

Low pressure water spray was used to flush the oil into the surf or areas where it could be recovered by portable skimmers deployed from shallow draft work boats. Rakes, shovels, and other hand tools were used to remove tar balls that drifted ashore. Approximately 9,095 Bbls of oil were recovered from shoreline

cleanup. Along with this, several tons of oiled vegetation were removed and burned along with the recovered oil in portable burners provided by Alaska Clean Seas.

6.3.5.4 Cleanup During Freezeup/Winter

During mid-September, Harrison Bay began to freeze. The ARCAT Skimmer returned to Prudhoe Bay and a winter camp was set up near Oliktok Point. Trans-Vacs and weir skimmers were used to recover oil that surfaced, as barges broke the thin ice cover. During October, the ice cover increased to ten inches and the barges returned to Prudhoe Bay.

From mid-October through mid-December, helicopters and manual labor were used to continue the cleanup operation. After the well was shut-in, oiled snow was placed in ice pits. Following this, the pits were sprayed with diesel fuel and burned. This procedure was also used to dispose oiled debris and sorbents. Holes were drilled through the ice to locate oil and suction skimmers were used for recovery. By mid-December, all oil found on and under the ice was cleaned up.

6.3.6 Conclusion

Approximately 177 days after the blowout occurred, the well was killed. It was estimated that 305,000 Bbls of oil were released. Approximately 50 percent of it was recovered during the response operation. The remaining 50 percent was lost due to natural dispersion and evaporation.

6.4 Arctic Diesel Transfer Spill in Open Water

6.4.1 Description of Events

During a fuel transfer operation between a drillship and its supply boat, a line ruptured and caused 1,000 gallons of diesel fuel to spill into the Beaufort Sea. The spill occurred in federal waters about 11 miles northwest of Kaktovik, Alaska.

6.4.2 Environmental Conditions

When the spill occurred, open water existed within a ten mile radius of the drillship. The temperature was 36°F and the wind was from the northwest at 6 knots. Shortly afterwards, heavy fog reduced visibility to a few feet and the wind speed increased to 10 knots with no change in direction. Five hours later, the fog lifted and the wind was from the southeast at 14 knots. Later, the wind increased to 20 knots and a 1 to 2 ft. harbor chop developed. Surface currents at the drillship were 1 knot.

6.4.3 Immediate Response

As soon as the spill was discovered, all transfer pumps were shut

down and the appropriate valves were closed. Prior to reporting the spill, the supply boat used the Reelpak boom on the drillship to contain most of the diesel fuel on the water surface. Once the slick was surrounded by the boom, a workboat was deployed to help the supply vessel maneuver the boom towards a calm water area on the leeward side of the drillship. While this was in progress, the drillship Captain reported the spill to the Minerals Management Service, North Slope Borough, State of Alaska, and the U.S. Coast Guard.

6.4.4 Cleanup Operations

When the boom containing the slick was moved to the leeward side of the drillship, cleanup equipment was placed on the supply boat. However, before the cleanup operation began, dense fog reduced visibility to several feet. In the interest of safety, cleanup was delayed until the fog lifted.

When the fog lifted five hours later, over 50 percent of the diesel fuel had escaped the boom and formed windrows which were about 2 miles long. Rope mop and weir skimmers deployed from the supply boat recovered all of the oil contained by the boom in approximately one hour. The recovered oil and water were stored in an empty fuel tank on the supply vessel. Later, it was taken to shore and burned as waste fuel.

After cleanup at the drillship was completed, the boom was retrieved and a helicopter directed the supply vessel to the leading edge of the largest windrow. An inflatable workboat was used to pull the boom from the supply boat. Following this, both boats worked the boom into a U-shaped configuration downwind of the windrow and held it in a stationary position. Once most of the diesel fuel was in the apex of the boom, the supply boat attached its end to the rubber boat which maintained tension on both ends of the boom. Next, the supply boat moved to the downwind side of the apex and skimmers were used to recover the diesel fuel. Three hours later, cleanup was completed and the boom was retrieved.

As the supply boat was enroute to another windrow, heavy cloud cover developed and it began to rain. Additionally, 20 knot winds created a 1 to 2 ft. harbor chop. When this occurred, the remaining oil could not be spotted by aircraft or the supply boat. Although the search continued for several hours, the slick could not be found. When the rain stopped and the sky cleared 8 hours later, the search resumed. However, there were no signs of the spill on the water surface or the shorelines.

6.4.5 Conclusion

During the spill, 1,000 gallons of diesel fuel were released to the environment. About 500 gallons were recovered at the drillship and another 100 gallons were recovered downwind of the spill site. The remaining 400 gallons were lost due to evaporation and natural dispersion.

Since all offshore spills during fuel transfer operations would occur at manned facilities, it is reasonable to expect the operator to assume responsibility for the cleanup operation. In most circumstances it is conceivable that the spill would be cleaned up and/or removed by evaporation or natural dispersion before the OSC arrived. Therefore, the OSC may not play a major role in the response operation for transfer spills associated with oil and gas activities in the Beaufort Sea.

6.5 Tanker Spill in August

6.5.1 Description of Event

On August 15, an explosion occurred aboard a Canadian tanker loaded with 550,000 Bbls of crude oil. The explosion damaged the tanker's steering system and ruptured several storage compartments causing 10,000 Bbls of oil to spill into the Beaufort Sea.

When the explosion occurred, the tanker was in 50 feet of water 25 miles northwest of Kaktovik, Alaska (Figure 6.5.1).

6.5.2 Environmental Conditions

When the spill occurred, seas were 3 to 5 feet and winds were gusting to 40 knots from the west. Open water existed within a 25 mile radius of the damaged tanker. Two days after the explosion, a storm developed with winds from the east at speeds up to 70 knots. Approximately 24 hours later, the storm stopped and the winds were 14 knots from the north. For several weeks following this, dense fog reduced visibility 25 percent of the time. The average temperature was 30°F.

6.5.3 Spill Behavior

The oil was a heavy crude. After contacting the water, it formed a slick which was 2 to 3 inches thick in some places. Within 24 hours, the spill formed a number of windrows which were over 30 miles long. At their widest point, several of the windrows were over 500 yards wide. Although 10,000 Bbls of oil were spilled when the explosion occurred, oil continued to leak from the tanker at an average rate of 1,000 Bbls per day.

6.5.4 Immediate Actions

The Captain shut down the engine room to minimize the potential for fire and additional explosions. Afterwards, Canadian authorities were notified and assistance was requested for off-loading the tanker and towing it to port for repair. The Canadian authorities volunteered to notify the vessel's owner but declined to provide any physical assistance, because the vessel was offshore of the United States.

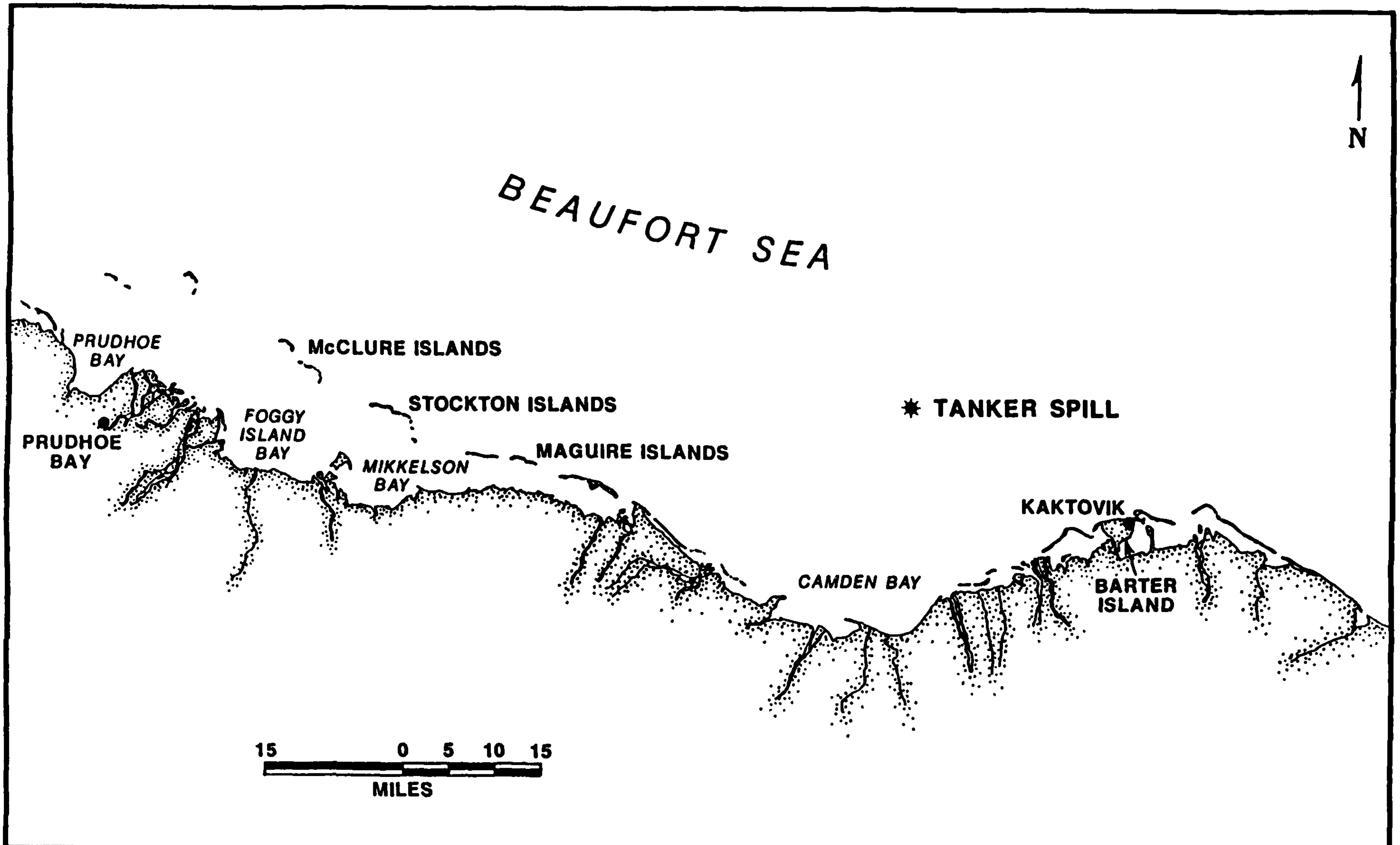


Figure 6.5.1

LOCATION OF TANKER SPILL

Eskimo whalers heard the explosion and used binoculars to spot the tanker. They notified the North Slope Borough Mayor who reported the spill to the U.S. Coast Guard in Anchorage, Alaska. The On-Scene Coordinator (OSC) alerted the Alaska Regional Response Team (RRT), the Pacific Area Strike Team (PAST), and the Scientific Support Coordinator (SSC). Following this, a North Slope aviation company was requested to conduct aerial surveillance to verify the accident report.

An hour later, the Aviation Contractor confirmed that a damaged tanker was drifting in the Beaufort Sea near Camden Bay and was responsible for a large oil spill which was drifting towards Kaktovik. In response, the OSC asked the Aviation Contractor to evacuate all personnel from the tanker. Additionally, the OSC requested North Slope Contractors with barges and tugs to proceed to the spill site and prepare to off-load the tanker.

The OSC ordered the Pacific Area Strike Team to depart for Deadhorse, Alaska (Prudhoe Bay) and advised the RRT that its support would be needed. Industry oil spill co-ops were requested to provide assistance for responding to the spill. Each co-op stated that its equipment could be leased. However, they would not be able to provide manpower for cleanup operations.

The Alaska Clean Seas (ACS) Executive Committee volunteered to deploy its self-propelled oil spill cleanup vessel "ARCAT Skimmer" if the Coast Guard would cover the cost. ACS also volunteered its 40-person basecamp at Prudhoe Bay for the response operation. The OSC accepted ACS' offer.

6.5.5 Response Planning

The OSC requested the NOAA office in Seattle to perform a trajectory analysis for the spill and determine if and under what conditions it would contact shore. Three hours later, NOAA reported that the oil would probably contact all of the shoreline in Camden Bay and most of the barrier islands between Brownlow Pt. and Prudhoe Bay. It was estimated that contact with land would begin within 24 hours.

About 10 hours after being activated, the Pacific Area Strike Team (PAST) and its response equipment arrived in Deadhorse, Alaska. Shortly afterwards, they met with the OSC in the ABSORB warehouse. During this meeting the following priorities were established:

- o Experienced tankermen would be contracted to assist Coast Guard personnel in off-loading the leaking tanker compartments into barges which were enroute to the accident site. Afterwards, the owner would be requested to remove the tanker from U.S. waters.

- o While the off-loading operation was in progress, the PST would deploy its skimming barriers downwind of the spill. To implement this, several response units were

established. Each unit would include a skimming barrier, two tugs, a barge, and one helicopter.

- Oil Spill Cleanup Contractors would be used to clean up and protect wildlife habitats and subsistence haulout areas. Input would be obtained from the RRT, SSC, and the North Slope Borough to identify and establish priorities for these areas.

  No immediate cleanup or protection would be recommended for coastal areas where wave action or shoreline erosion would remove oil within several months.

- Approval for dispersant use would be requested for oil slicks in areas more than five miles from shore with water depths greater than 20 feet and waves greater than 1 foot. If approval was granted, the ARCAT Skimmer and aircraft would be used for dispersant deployment.

6.5.6 Offshore Containment and Cleanup

About 24 hours after the explosion occurred, contractors began to off-load oil from the leaking tanker into barges mobilized from Prudhoe Bay. This operation was stopped several times due to storms which moved through the area. On August 30th, off-loading was completed. Afterwards, the tanker was towed to the Canadian border where it was turned over to the Canadian Coast Guard.

Four skimming barriers provided by the PST were deployed in stationary positions downwind of the oil slick. Both ends of each barrier were held in position by tug boats. The pump float and hydraulic power pack for each skimming barrier were mounted on the barge which transported it to the deployment location. Oil recovered by the skimming barrier was stored in the barge supporting the pump float. Manpower for this operation was provided by the PST, Marine Operators, and Oil Spill Cleanup Contractors.

The response units performed well in waves up to 3 feet and winds up to 20 knots. When the waves exceeded 3 feet, the weirs were either too high above or too far below the oil-water interface for effective recovery. Also, waves greater than 3 feet and winds greater than 20 knots caused oil to splash over the skimming barrier. Despite these problems, each skimming barrier recovered up to 150 Bbls. of oil per hour. To minimize the amount of water that was collected with the oil, the pumps were not turned on until the oil was several inches thick in the apex of the skimming barrier. On several occasions, when the water was calm, the pumps were not turned on until the oil was 1 foot thick.

Although the response units performed well in deep water, the drafts of the tugs and barges prevented them from being deployed in waters less than 6 feet deep. Consequently, oil in shallow near-shore waters could not be recovered with this technique.

About 20 hours into the response operation, weather forecasts indicated that a storm with winds up to 70 knots would occur within 4 hours. In view of this, the OCS ordered the response units to seek shelter on the leeward side of Barter Island. To expedite this, the skimming barriers were not removed from the water; instead, they were towed behind the barges which were pulled by the tugs. At Barter Island, the skimming barriers were secured to the downwind side of the barges.

When the storm was over, helicopters directed the response units to offshore areas containing oil. Shifting winds frequently caused floating ice to approach the skimming barriers. When this occurred, the tugs reduced the swath width (normally 300 feet) so that the ice would not enter the catenary formed by the skimming barrier. On several occasions, the cleanup operation was stopped and the skimming barrier was placed on the downwind side of the barge to protect it from heavy ice encroachment. When dense fog was developing in areas containing ice, this technique was implemented as a precautionary measure to protect the skimming barriers.

6.5.7 Considerations for Dispersant Use

On August 25th several bowhead whales were spotted near the U.S. - Canadian border. Since these whales are on the endangered species list, the OCS met with the representatives from the Alaska Eskimo Whaling Commission (AEWC), National Marine Fisheries Service (NMFS), North Slope Borough (NSB), and RRT.

The OSC was advised that the oil spill could adversely affect the whales in several ways. It could foul their baleen and interfere with their feeding. Also, large quantities of oil could be ingested if whales feed in a slick. The oil could also damage their eyes or cause skin infections. Since the oil could adversely affect whales that entered the slick, it was recommended that more equipment be deployed to clean up the spill before the whales enter U.S. waters.

The OSC and RRT agreed that dispersants may be more effective than mechanical equipment for ensuring that oil would not be in the bowhead whale migration corridor. The NSB stated that dispersants would force the oil into the water where it could enter the aquatic food web. Since many Eskimos rely on fish and marine mammals for most of their nutritional needs, their food source would be contaminated if dispersants were used.

In view of these concerns, the RRT granted approval for dispersant deployment only in offshore areas more that five miles from shore where sufficient energy exists to maximize dispersant effectiveness. The RRT also stipulated that only dispersants which were proven to be effective for the type of oil spilled could be used.

6.5.8 Shoreline Protection and Cleanup Operation

About 24 hours after the spill occurred, oil began to coat the shoreline in Camden Bay. The RRT assisted the OSC in establishing priorities for shoreline cleanup. It was decided that protecting coastal wildlife habitats which have not been coated with oil would receive the highest priority. Afterwards, effort would be directed towards cleaning up wildlife habitats which were coated by oil.

It was determined that personnel for this operation could be obtained from North Slope Contractors' union halls in Anchorage and Fairbanks, as required. Supervision would be provided by Oil Spill Cleanup Contractors and Consultants from Anchorage. To ensure that additional manpower would be available, the OSC requested the Governor to activate the National Guard. The Governor agreed to do this if sufficient manpower could not be obtained from the private sector.

About 72 hours after the spill began, a 100-person labor force was assembled at Prudhoe Bay. Twenty 5-person cleanup teams were formed and provided temporary housing in Prudhoe Bay hotels. Each team was provided a leader who was familiar with shoreline response techniques. Each team was also provided one response box and one life support box obtained from the ABSORB warehouse. The team leaders familiarized their personnel with the cleanup equipment and arctic clothing contained in these boxes.

Based on information provided by the NOAA Oil Spill Trajectory Model, helicopters were used to transport personnel and equipment to the wildlife habitats and sensitive shorelines which would be contacted by oil within 24 hours. Remote camps were set up with large tents obtained from the ABSORB warehouse and North Slope Contractors. Afterwards, boom was deployed to protect the shorelines. When oil contacted the upwind side of the boom, it was recovered with portable skimmers and stored in pillow tanks that were placed in slings for helicopter transportation.

Low pressure water spray was used to flush the oil from wildlife habitats and herd it to areas where it was recovered by portable skimmers. Oiled soil and debris, which could not be cleaned by this technique, was removed and placed in heavy duty plastic bags and 55-gallon drums.

6.5.9 Recovered Oil Disposal

Oil recovered during the offshore cleanup operation was placed in barges and taken to the Prudhoe Bay west dock where it was burned in a smokeless flare burner. Oiled debris was burned in the Coast Guard Trecan Incinerator which was set up at Prudhoe Bay. Oiled soil was placed in 85-gallon over-pack containers and shipped to EPA approved disposal facilities in the Lower-48. The oil transferred from the leaking tanker was eventually returned to its owner.

6.5.10 Conclusion

About 25,000 Bbls. of oil were spilled. Approximately, 5,000 Bbls. were recovered offshore. Another 5,000 Bbls. were recovered from shoreline cleanup operations. Based on the nature of the oil, it was estimated that 20 percent evaporated. The remaining 40 percent was stranded along shorelines and removed by natural processes.

During this operation, four U.S. Coast Guard skimming barriers were deployed and over 100 persons were required for shoreline cleanup. The spill began on August 15 and the cleanup operation was terminated by the OSC on September 15. Oil which was left in place was eventually removed by natural processes and no dispersants were used during this response operation. Although the bowhead whale migration began, no adverse impact to the whale population was observed.

6.6 Pipeline Leak During Winter

6.6.1 Description of Event

On January 30th, an audit for an offshore production facility revealed that a 20,000 Bbl difference in the amount of oil pumped and the amount of oil received at the onshore terminal. After being advised of this discrepancy, the Operator conducted a flow test to determine if it was due to error in meter readings or miscalculations by the technical staff. The test revealed that the amount of oil being received at the onshore terminal was 500 Bbls per day less than the amount pumped by the production facility. Therefore, it was concluded that the subsurface pipeline was leaking.

The Production Facility was located on a gravel island in 30 feet of water about 7 miles east of the Prudhoe Bay west dock. It produced 100,000 Bbls of oil per day which was transferred 4 miles to shore through a 2 ft. diameter subsurface pipeline. The production facility was connected to the main land by an ice road which paralleled the corridor for the subsurface pipeline.

6.6.2 Environmental Conditions

When the spill was detected, the Beaufort Sea was covered with 5 feet of solid ice. The temperature was minus 25°F and winds were 10 knots from the east. Visibility was limited due to blowing snow and 24 hours of darkness. On several occasions visibility was reduced to zero by whiteout conditions.

6.6.3 Spill Behavior

Oil was escaping from faulty welded connections in the pipeline at a rate of 21 Bbls. per hour. This section of the pipeline was located in 20 feet of water approximately 1/2 mile from the

production facility. As the escaping oil contacted the under-surface of the ice, spreading was limited by weak currents (less than 0.1 knots) and rough ice edges extending downwards from the ice. Directly above the leak, the oil formed a pool which was several feet thick. As the depth of the pool exceeded the downward extensions of the ice roughness, the oil spread and increased the dimensions of the spill.

6.6.4 Immediate Actions

As soon as it was suspected that the pipeline was leaking, the production wells were shut-in and all transfer pumps were stopped. This reduced the pressure in the pipeline and stopped the leak. Afterwards, the spill was reported to the National Response Center and the U.S. Coast Guard in Anchorage.

6.6.5 Response Planning

Several hours after the spill was reported, the OSC met with the Operator in Anchorage, Alaska to discuss plans for responding to the spill. The Operator assumed full responsibility for the spill and stated that divers would be used to inspect the sea floor along the pipeline corridor.

Since the spill was contained by existing environmental conditions and did not present an immediate threat to the wildlife habitats or subsistence resources, the Operator requested permission from the OSC to delay cleanup until the pipeline was repaired and the production facility was back in service. When the OSC asked how long it would take, the Operator commented that 2 to 3 days would be required to mobilize the divers and locate the leak. A week or less would be required to make the necessary repairs. Once the leak was repaired and the extent of the spill was defined, holes would be drilled through the ice so that the oil could be cleaned up by vacuum trucks.

The OSC agreed that cleanup could be delayed up to two weeks. Additionally, the OSC requested the Operator to flush the pipeline with water to remove all of the oil in case it was necessary to install a new section. The Operator agreed to do this as soon as the leak was located.

6.6.7 Response Operation

About 72 hours after the spill was reported, divers began to inspect the pipeline corridor to find the leak. To expedite the search, three teams consisting of two divers each were deployed at different locations. Each team was equipped with a metal detector, camera, and high beam lanterns. The leak was discovered on the second day of the search. It was located 800 yards from the production facility in 20 feet of water. An inspection of the pipeline revealed that the leak was due to several faulty connections. The divers also reported a large pool of oil, approximately 1/2 mile in diameter, on the under-surface of the ice.

As requested by the OSC, the pipeline was flushed to prevent additional oil from spilling during the repair operation. One day later, the pipeline was repaired by welding a metal band over the leaking connection. Following this, the pipeline was pressure tested to ensure that the repair was adequate. Afterwards, the Production Facility was returned to service.

While the repair work was in progress, graders and front-end loaders were used to construct several 360 degree snow rings on the ice surface over the areas containing large quantities of oil. When each ring was 3 feet high, it was sprayed with water to form an impermeable barrier. Next, augers were used to drill holes inside of the ice ring. Vacuum trucks located on the ice road were used to suck the oil from these holes. During a two week operation, the vacuum trucks recovered about 17,000 Bbls of oil. The recovered oil was taken to the treatment plant at the offshore Production Facility. After being treated, it was pumped to the onshore terminal.

Two problems were encountered while using the vacuum trucks. On a number of occasions, low temperatures caused water to freeze in long sections of suction hose. Eventually, this problem was resolved by tracing each hose with heating tape. The other problem was that the recovery operation stopped when the oil thickness was equal to the depth of the under ice roughness. In some locations, this caused several inches of oil to remain under the ice.

An attempt was made to recover the residual oil by cutting the ice and removing large blocks. However, after blocks of ice were removed and capsized, low temperatures caused the oil to solidify. This made it difficult to separate the oil from the ice. In view of this, it was decided to terminate the cleanup operation until spring breakup.

Although breakup began during late May, the oil did not surface through brine channels as expected. Instead it began to slowly appear between cracks in the ice. As the broken ice concentration decreased, the amount of oil on the water surface increased. Both the OSC and RRT suggested air-deployable ignitors and in-situ burning to remove the oil. However, due to the location of the oil relative to the Production Facility, the Operator objected to this technique.

When the broken ice concentration dropped to 75 percent, barges containing portable skimmers were used to clean up the oil. When the ice concentration declined to 50 percent, Alaska Clean Seas' self-propelled skimming vessel, "ARCAT Skimmer", was deployed. From mid-June through late August, 1,000 Bbls. of oil were recovered. This oil was stored in a barge and taken to the Prudhoe Bay west dock where it was burned in a smokeless flare burner.

6.6.8 Conclusion

About 18,000 Bbls. of oil were recovered during this response operation. Manpower was provided by the Operator's crew at the Production Facility. Equipment was leased from North Slope Contractors and supplemented by equipment obtained from Alaska Clean Seas' ABSORB warehouse.

Although oil was on the water surface during open water, it did not contact shore. It was assumed that the 2,000 Bbls of oil which were not recovered were lost to evaporation and natural dispersion in the water column.

6.7 Pipeline Leak From Freezeup Through Breakup

6.7.1 Description of Event

During the initial phase of breakup, aircraft pilots reported numerous pools of oil on the ice surface about 4 miles south of an offshore Production Facility in the Beaufort Sea. The Production Facility was 12 miles north of Pitt Point in 50 feet of water.

6.7.2 Environmental Conditions

When the pools of oil were discovered, breakup was beginning. The shorefast ice along the coastline was thawing. Further offshore, puddles were forming on the ice and open leads were developing. The average temperature was 30°F, and winds were from the east at speeds up to 20 knots.

6.7.3 Spill Behavior

As breakup progressed, larger pools of oil formed on the ice surface. These pools resulted from oil which migrated to the surface of the ice through brine channels. Since the oil attracted solar radiation, it caused ice decay and melting to accelerate.

When the ice sheet broke, large quantities of oil began to surface between the cracks. As soon as the oil surfaced, its lighter fractions began to evaporate. Initially, spreading was limited by broken ice. However, as the ice concentration decreased, the spreading rapidly increased under the influence of shifting winds.

6.7.4 Immediate Actions

The spill was reported to the Environmental Protection Agency. They reported it to the National Response Center and the U.S. Coast Guard in Anchorage, Alaska. Afterwards, the OSC alerted the Pacific Area Strike Team(PAST), the Alaska Regional Response Team (RRT), and the Scientific Support Coordinator (SSC).

The OSC contacted the Production Facility to determine if it would assume responsibility for the spill. The Operator commented that there was no indication that the spill was created by the Production Facility facility and as such they would not assume responsibility for the cleanup operation. However, they agreed to provide assistance as requested by the OSC to contain and cleanup the spill and identify its source.

After meeting with the Operator, the OSC activated the PAST and RRT. The OSC also requested the SSC to report to the alternate Regional Response Center in Anchorage. Six hours later, the OSC, PAST Commander and SSC departed for the Beaufort Sea to assess the immediate impact that the oil could have on the environment and obtain information which would help them develop a response strategy.

On arriving at Deadhorse, Alaska an Aviation Contractor provided transportation to the spill site.

6.7.5 Response Planning

The OSC established a base camp at one of the hotels in Deadhorse, Alaska. Following this, the OSC held a meeting with the RRT and SSC. Also, the Production Facility Operator, North Slope Borough (NSB), and Cleanup Contractors and Consultants were invited to attend this meeting. The following priorities were established:

- The Operator was requested to inspect all transfer lines from his facilities to shore terminals.

- In-situ burning would be used to reduce the amount of oil on the water surface as soon as the source for the spill was identified. In the meantime, portable skimming equipment would be used to clean up the oil whenever ice conditions permitted.

- Oil Spill Cleanup Contractor's would be used to clean up and protect wildlife habitats and subsistence haulout areas. Input would be obtained from the RRT and the North Slope Borough to identify and establish priorities for these areas.

  Immediate cleanup or protection would not be recommended for coastal areas where wave action or shoreline erosion would remove oil within several months.

- Approval for dispersant use would be requested for oil slicks in areas more than five miles from shore with water depths greater than 20 feet and waves greater than 1 foot. If approval was granted, the ARCAT Skimmer and aircraft would be used for dispersant deployment.

6.7.6 Spill Source Identification

As requested by the OSC, the Operator reviewed all production records for the preceding year. These records revealed that, from October through May, the amount of oil received by the onshore terminal facility was 30,000 Bbls less than the amount produced, representing a daily loss of 143 Bbls. Since the facility produced 200,000 Bbls. of oil per day, this loss was not detected.

To confirm the source for the spill, the Operator contracted divers to inspect the pipeline from the Production Facility to the onshore terminal. On the third day of the inspection, they found a small leak in the pipeline about 4 miles south of the Production Facility. The pipeline was repaired by welding a metal band over the leak. Following this, the pipeline was pressure tested to ensure that the repair was adequate.

The Operator agreed to assume the responsibility for the spill and cover all cost associated with the cleanup operation.

6.7.7 Response Operation

Three ice-strengthened barges were equipped with rope mop skimmers, Trans-Vacs, storage containers, transfer pumps, living quarters, and a helicopter pad. Manpower for this operation was provided by Oil Spill Cleanup Contractors and Oilfield Service Companies at Deadhorse, Alaska.

During mid-June the broken ice concentration dropped to 75 percent and the barges with the cleanup crews departed for the spill site. Each barge was pushed by an ice-strengthened tug at speeds ranging from 1 to 5 knots, depending on ice conditions.

Within 36 hours after departure, the response barges encountered the oil slick. Rope mop and hand held weir skimmers were used to clean up oil between ice floes. Throughout this operation, it was necessary to remove these skimmers from the water so that large pieces of ice could pass.

The recovered oil was placed in storage containers (Baker Tanks) on the decks of the response barges. When each container was filled, it was allowed to set for several hours so that phase separation would occur. Afterwards, the water was drained and returned to the sea. Following this, additional recovered oil was placed in the storage container, and this procedure was repeated until it was filled with oil. Afterwards, the storage containers were taken to shore where the oil was fed to a flare burner for disposal.

From mid-June through late September, the response barge recovered 100 to 200 barrels of oil per day. On several occasions, the cleanup operation was stopped by dense fog and storms.

When the broken ice concentration dropped to 50 percent, the ARCAT Skimmer was deployed. It was able to effectively maneuver between ice floes and recover up to 100 Bbls. of oil per day. In areas that did not contain any broken ice, a V-shaped boom configuration was used to increase the ARCAT Skimmer's cleanup rate. On several occasions, this technique enabled the ARCAT to recover 180 Bbls. of oil per hour. Although higher recovery rates were possible, they were limited by the vessel's internal storage capacity (180 Bbls.).

6.7.8 Shoreline Cleanup

Shoreline areas were placed into two categories: 1) those where natural forces such as wave action or erosion would eventually remove oil that contacted it, and 2) those where stranded oil would remain if no countermeasures were implemented. The latter was identified as having a higher sensitivity due to frequent use by migratory waterfowl during the summer. As a result, they were given the highest priority for protection. Input was requested from the Alaska Regional Response Team (RRT) to ensure that the correct priorities were established.

Priorities and techniques for shoreline cleanup were carefully coordinated with state and federal agencies. For sensitive areas where cleanup operations would do more damage to the environment than the oil, it was mutually determined by the RRT, OSC, and Operator that no action would be taken. Appropriate steps recommended by state and federal agencies were used to protect migratory waterfowl from contact with areas that contained oil. In most cases, this entailed the use of scare-away cannons obtained from the ABSORB warehouse.

In areas that required cleanup, low pressure water spray was used to flush the oil into the surf or areas where it could be recovered by portable skimmers deployed from the shoreline or shallow draft work boats. Rakes, shovels, and other hand tools were used to clean up tar balls and oiled debris. Approximately 2,000 Bbls. of oil were recovered from shoreline cleanup. The recovered oil and debris were burned in portable incinerators provided by Alaska Clean Seas. Cleanup crews deployed boom to protect sensitive shoreline areas. In shallow areas where the shoreline could not be accessed by supply boats or barges, boom, shoreline response equipment, and personnel were transported to pre-designated sites by helicopter.

6.7.9 Conclusion

During a 3-month cleanup operation, approximately 14,000 Bbls. of oil were recovered offshore. This oil was burned onshore in a flare burner. Another 2,000 Bbls. of oil were recovered during the shoreline cleanup operation. Portable open pit incinerators were used to burn oil-soaked debris. The remaining 14,000 Bbls. were lost due to natural dispersion and evaporation.

6.8 Drillship Blowout

6.8.1 Description of Event

On September 30th, a subsea blowout occurred when ice encroachment forced a drillship off location and broke the riser below the blowout preventer. Based on previous well tests in this area, it was estimated that the well released about 5,000 Bbls. of oil per day, 6,000 Bbls. of water per day, and 800 scf of gas per Bbl of oil.

When the blowout occurred, the drillship was located 12 miles northeast of Kaktovik, Alaska in 60 ft. of water (Figure 6.8.1). Along with snapping some of the anchor lines, the ice also damaged the drillship's rudder and propellers.

6.8.2 Environmental Conditions

When the incident occurred, winds were from the north at 60 knots and visibility was reduced to 0.25 mile by blowing rain. Prior to the incident, the sea was covered with small pieces of ice, less than 10 ft. in diameter. The ambient temperature was 33°F.

6.8.3 Spill Behavior

Turbulence created by expanding gases from the well caused an emulsion to form as the the formation fluid rose through the water. When the emulsion reached the water surface it formed a thin slick that rapidly mixed with moving ice.

When freeze-up began, turbulence created by gases breaking the water surface prevented ice formation in the immediate area of the blowout. However, during mid-winter, wind pushed a thick sheet over the blowout. As a result, the oil began to coat the under-surface of the ice and spread under the influence of subsea currents which ranged from 0.1 to 0.5 knots.

The blowout lasted for 5 months and released 750,000 Bbls of oil. It stopped due to reservoir depletion. During breakup, pools of oil formed on the melting ice. As warmer temperatures developed and the ice cover continued to deteriorate, large quantities of oil surfaced between broken ice pieces.

6.8.4 Immediate Actions

As soon as the ice forced the drillship off location, the anchors were released and an attempt was made to move the vessel to safe waters. When the drillship failed to move in the correct direction, the captain recognized that the rudder was damaged. The U.S. Coast Guard was notified and all personnel were evacuated by the supply boats.

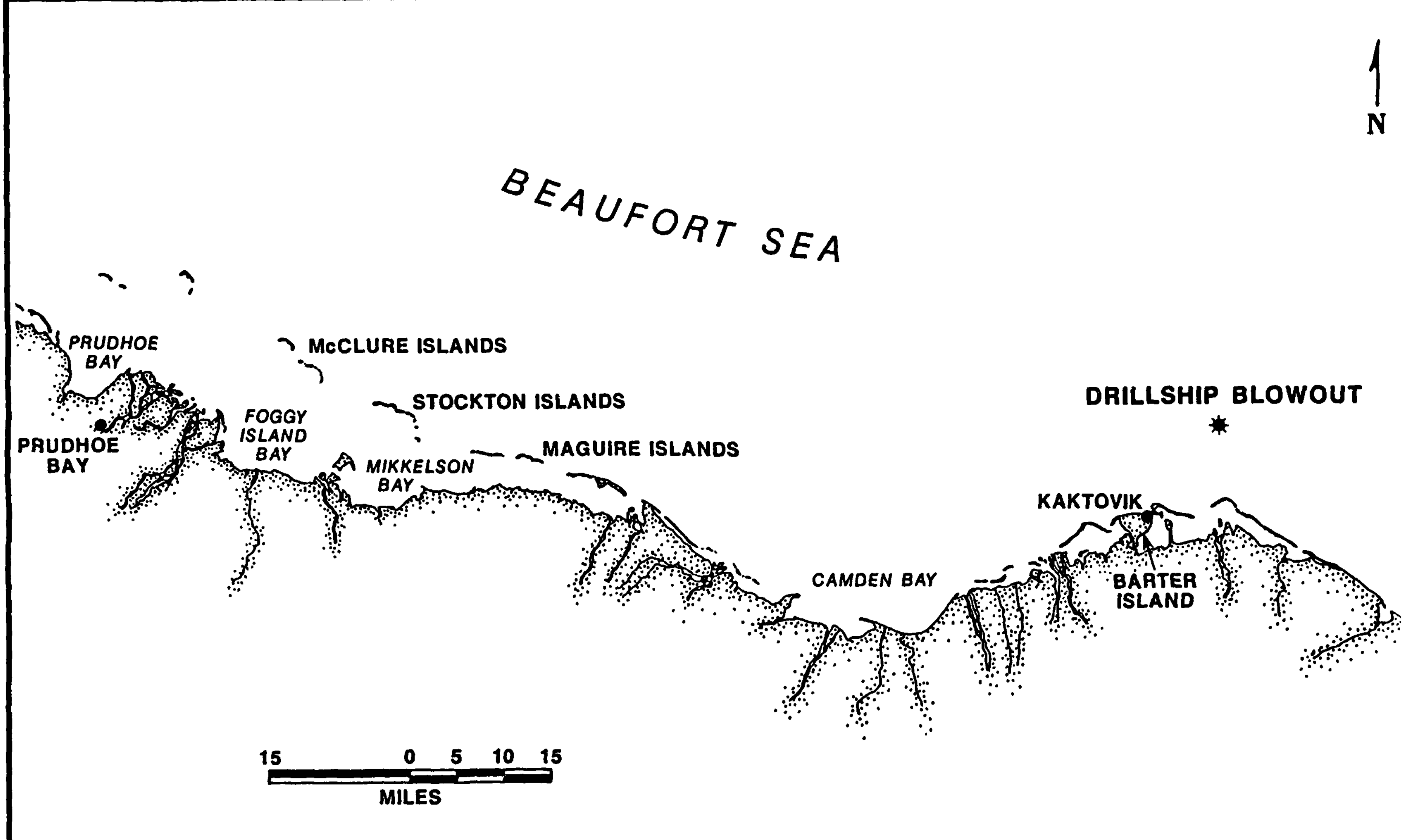


Figure 6.8.1

LOCATION OF DRILLSHIP BLOWOUT

6.8.5 Response Planning

The Operator requested CANMAR (Canadian Marine) to release one of its drillships so that it could be used to drill a relief well. CANMAR stated the Explorer III was operating in the Canadian Beaufort Sea and would be released within 48 hrs.

The Operator reported the blowout to the Minerals Management Service, National Response Center, and U.S. Coast Guard in Anchorage. On the morning following the blowout, the Operator and OSC held a meeting to develop a response strategy. Prior to this meeting, the OSC notified the Alaska Regional Response Team, Pacific Area Strike Team, and Scientific Support Coordinator that their help may be required.

The Operator informed the OSC that plans were under way to drill a relief well. Approximately 45 days would be required to complete this well and kill the blowout. This includes 5 days to mobilize the Explorer III and rig-up, 30 days to drill the relief well and 10 days for the kill operation. This estimate assumes that neither ice conditions nor weather would hinder the relief well operation.

The OSC questioned if it would be possible to complete a relief well before ice conditions prohibited offshore operations in the Beaufort Sea. The Operator commented that ice conditions were unpredictable and the best they could do would be to proceed as fast and as safely as possible. Also, to maximize the extent of the drilling window, two ice breakers would be used to keep the sea open as long as possible.

Since freeze up was in progress, it was recognized that mechanical cleanup would not be feasible. Therefore, it was agreed that in-situ burning would be the best option for reducing the amount of oil on the water surface.

6.8.6 Response Operation

On October 2, ice-strengthened tug boats towed the damaged drillship to a port at Tuktoyaktuk, Canada. Afterwards, a helicopter dropped several floating incendiary devices onto the water surface above the blowing well. These devices were equipped with time-delayed ignitions to ensure that the helicopter would have sufficient time to get out of the area in case an explosion occurred.

The ignitors cause a very large fireball to form. However, it was discovered that the fire resulted from burning gases and the oil on the water surface was not ignited. The gases continued to burn until the blowout location was covered by solid ice.

The Explorer III reached the relief well location and began operation on October 5. Ten days later, a storm forced the Explorer III to abandon location and seek shelter on the leeward

side of barrier islands. After the storm ended, drilling continued for another 15 days and was terminated when ice conditions dictated that the Explorer III return to port.

6.8.7 Cleanup Operation

During early June, melt pools containing oil formed on the ice surface near the blowout site. When breakup occurred, large quantities of oil surfaced between the ice floes.

Since the water surface was calm at the blowout site, divers were deployed to evaluate the well condition. They reported that fluids were no longer escaping from the well. Ignitors obtained from the ABSORB warehouse were used to ignite the oil which was contained by broken ice. Burning continued until the ice concentration decreased to the point where it no longer contained the oil. It was estimated that 150,000 Bbls of oil were removed by in-situ burning.

By mid-June, barges containing portable skimmers were used to remove burn residue and oil from the water. In locations where thick concentrations of oil were encountered, the skimmers mounted on each barge were able to recover up to 200 Bbls of oil per day.

During late September, the recovery operation was terminated when ice formation prevented effective cleanup. Together, the response barges and Alaska Clean Seas' self-propelled skimming vessel "ARCAT Skimmer" recovered about 200,000 Bbls of oil. This oil was taken ashore and burned in flare burners. Oil-coated debris was burned at Barter Island in portable incinerators. Approximately 10,000 Bbls. of oil were recovered during shoreline cleanup operations.

6.8.8 Conclusion

The blowout lasted for 5 months and discharged 750,000 Bbls of oil. Ice conditions prevented a relief well from being completed. The blowout died when the reservoir was depleted. About 350,000 Bbls. of oil were removed from the water by in-situ burning and mechanical cleanup. The remaining oil was lost to evaporation and natural dispersion. During the response operation, 10 barges containing portable cleanup equipment were deployed.

Personnel for the cleanup operation were hired from Oil Field Service Companies at Deadhorse, Alaska. They were trained and supervised by Oil Spill Cleanup Contractors and Consultants. The Operator assumed the responsibility for the response operation. As a result, the OSC monitored the cleanup activities and provided input where appropriate.

Appendix A

Oil Spill Skimmer Data[1]
Table of Contents

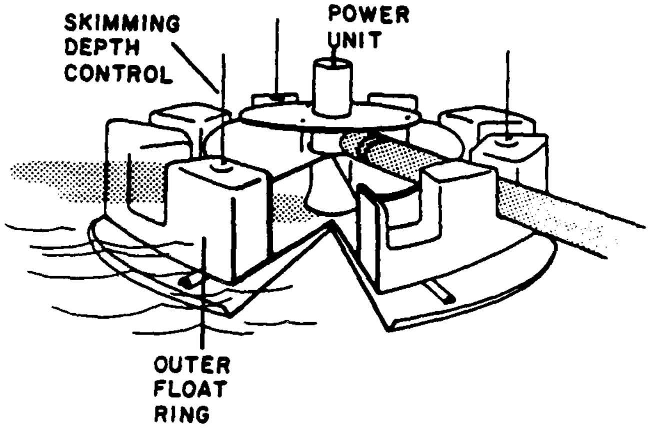
Note: 1. See Tables 7-1 and 7-2 for additional Skimmer data.
2. Information presented on these pages was taken from "A Catalogue of Oil Skimmers", Report EPS 3-EP-83-1.

ACME PRODUCTS, CO.
P.O. Box 51388
Tulsa, OK 74151
USA

SK-39T
(Tunnel Skimmer,
Floating Saucer)

COLLECTION PRINCIPLE

A double weir system identical to that of the Acme SKL-51T (see preceeding entry) effects the oil recovery process. An impeller driven by an engine within the skimmer head initiates the flow of fluid over the weirs.



PHYSICAL SPECIFICATIONS

Overall Diameter (cm)	117
Height (cm)	61
Discharge Hose Diameter (cm)	10.2
Weight (kg)	63 (with gasoline motor)
Power Unit	optional air, electric or gasoline drives (1.7-4 HP)
Materials of Construction	fibreglass float ring, epoxy-coated aluminum body, stainless steel impeller (replaces bronze impeller in earlier models)

MODE OF OPERATION

Placed in boomed-off area alongside vessel or dock or near shoreline. Self-contained when gas powered, otherwise compressor or source of electricity required (115/230 or 230/460 V AC). Launching by two persons is possible.

PERFORMANCE

The test data below reflect work carried out at OHMSETT using lube oil. Like its 51T counterpart, the 39T tends to pick up a significant volume of water. The U.S. program determined the dependence of oil recovery capacity on the diameter and length of the connection hose although no clear correlation of skimmer performance and wave conditions was observed. The U.S. evaluations were conducted in a slick thickness of about 2.5 cm; this resulted in substantially higher oil recovery rates and oil content in the collected product versus the results obtained using the 51T in thin slicks (1 cm or less). The evaluation work clearly indicates the importance of applying the Acme Skimmers to oil that has been contained and concentrated in order to maximize their effectiveness.

U.S. Test Results

Air Temp. (°C)	Oil Viscosity (cm^2/s @ 20 °C)	Oil Temp. (°C)	Wave Height (m)	Wave Length (m)	Wave Period (s)	Oil recovery Rate (m^3/h)	Oil Content (%)
11	16.97	14	0	0	—	4.3	27.3
18	2.82	25	0	0	—	1.4	57.1
16	3.03	19	0.6	9.1	3.0	2.9	41.6
18	3.43	19	0.3	13.7	4.0	3.7	56.7

OPTIMUM APPLICATION

In concentrated, light oils several centimetres in thickness contained by a spill barrier in calm, debris-free water; storage/separation capacity required.

ADDITIONAL PERFORMANCE INFORMATION

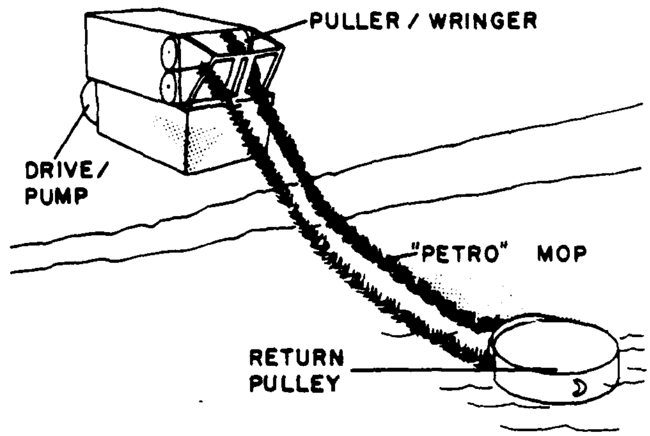
McCracken, W.E., Performance Testing of Selected Inland Oil Spill Control Equipment, EPA 600/2-77-150, U.S. Environmental Protection Agency, Cincinnati, OH, (1977).

CENTRIFUGAL SYSTEMS, INC.
8319 Bauman Road
Houston, TX 77022
USA

PULLER-WRINGER
(CSI Models 14, 24, 26, 29 and 212)

COLLECTION PRINCIPLE

An endless woven polymeric mop pulled by a drive/wringer assembly is passed through a slick. Product is squeezed from the mop, deposited in a sump integral to the wringer, and transferred by pump to ultimate storage. An idler pulley anchors the floating end of the mop.



PHYSICAL SPECIFICATIONS (typical values given; various models in each group marketed)

	14	24	26	29
Length (cm)	55.9	104	183	236
Width (cm)	37.5	81	91	117
Height (cm)	5 917	127	112	137
Mop Diameter (cm)	10.2	10.2	15.2	22.9
Materials of Construction	steel wringer/drive assembly, polypropylene fibre mop			
Weight (kg)	16	200	454	907
	varies with choice of drive and pump			
Pump	centrifugal, progressing cavity and lobe units are available in sizes 1.9 to 10.2 cm			
Drive Units	electric 115/230 V single-phase and 230/460 V 3-phase motors, 1/3 to 15 HP; air-cooled diesel engines also sold with models 26 and 29 rated at 7 to 18 HP			

MODE OF OPERATION

All models outfitted with a pump require mechanical lifting assistance; electric units need various power sources according to voltage, phase, etc. The wringer/power assembly is positioned on a working platform or on shore and the woven mop extended into stationary, contained oil. The return idler, through which the far end of the mop passes, is secured by anchoring or tying off to an appropriate point. Facilities for product storage are required to complete the recovery process. Advancing skimmers that are self-contained are also available.

PREDICTED PERFORMANCE

No evalution data are known for Centrifugal Systems, Inc. equipment.

See also Oil Mop Inc. entry.

The polymeric endless rope concept has been comprehensively evaluated in Canada, the United States, the United Kingdom and in other countries. It has also been widely applied to spills. Performance is generally reported to be very good over a wide range of oil viscosities, excluding highly viscous products such as Bunker C particularly at lower temperatures. The configuration of the recovery component permits its operation in moderate wave conditions and in many forms of debris. As Centrifugal Systems, Inc. has done, machines are available in several forms including an advancing skimming concept (see Oil Mop Inc. Dynamic Skimmer entry).

Recovery efficiencies should vary with mop speed, oil type and environmental conditions; however, generally slightly higher recovery rates should be expected for light to medium viscosity oils than for more viscous products. Higher oil content is more likely with the heavier oils. Prior concentration of the oil to be collected within a boomed-off area would ensure maximum saturation of the mop and optimum performance. The company's wide choice of pumps and drive units should satisfy any conceivable engineering requirement of the devices offered. The twisting configuration of the mop is not likely to affect its ability to contact oil; however, its flattened webbing core should reduce the likelihood of either jamming or slippage.

PREDICTED OPTIMUM APPLICATION

In light to heavy oils, excluding non-flowing products contained in thicknesses of several millimetres and more; in a variety of debris forms; in calm to moderate wave conditions.

ADDITIONAL PERFORMANCE INFORMATION

For appropriate references, see Oil Mop, Inc. entries.

OTHER DATA

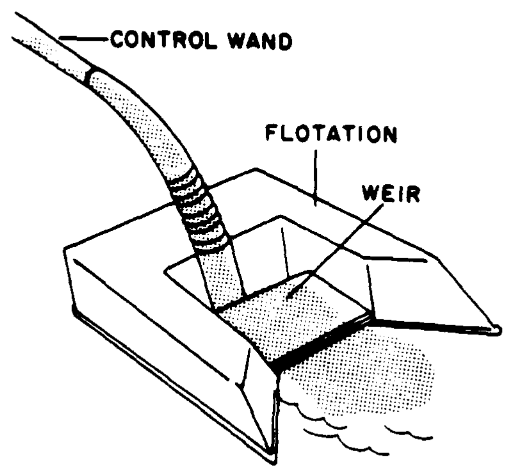
Centrifugal Systems, Inc. has also constructed self-propelled catamaran vessels incorporating multiple mops between the hulls as a zero relative velocity oil collection system. One craft is 29 m long with a 12 m beam and a displacement of 272 tonnes, while another is about 15 m in length with a 5 m beam and weighs 25 tonnes. The former utilizes multiple 46 cm mops while the latter sweeps with 30 cm mops.

DOUGLAS ENGINEERING
5168 Brookside Lane
Concord, CA 94521
USA

SKIM-PAK

COLLECTION PRINCIPLE

A weir mechanism self-adjusts with flow and wave conditions to result in product being suctioned off through a hollow wand via an external pump to storage.



PHYSICAL SPECIFICATIONS (two sizes are sold)

	2000 Series	4000 Series
Length (cm)	53	71
Width (cm)	53	71
Height (cm)	15	20
Draught (cm)	7.5	10
Weight (kg)	7	9
Materials of Construction	fibreglass body, polymer hinge aluminum wand (4000 series also fabricated in stainless steel)	
Debris	screen optional	

MODE OF OPERATION

The Skim-Pak is connected to a pump or vacuum truck and placed in a concentrated slick. Skimming depth and rate are controlled by pump speed and a butterfly valve on the control wand. Two rigging arrangements allow both direct manoeuvering by one person and unattended skimming. The skimmer's small size provides for ease of handling and portability.

PERFORMANCE

Environment Canada directed evaluation of the Skim-Pak 2000 series in conjunction with a 7.6 cm Spate pump at a refinery settling pond in air temperatures of 0 to 2 °C and a water temperature of 10 °C using Venezuelan crude (API Gravity 24 °).

Slick Thickness (mm)	Valve Opening	Oil Recovery Rate (m^3/h)	Oil Content (%)
6	1/2	0.41	5
15	1/2	1.35	20
16	1/4	0.70	43
18	1	1.46	21

Oil content of the recovered liquid was found to increase with lower pumping rates (2 m^3/h), smaller valve opening (1/4 turn) and thicker slicks. For higher removal rates in thinner slicks, a settling tank was recommended by the test team. The skimmer was judged to be light, easy to use, and readily controlled by the wand/valve/pump and self-adjusting weir arrangement. The wand provides a practical means to optimally position the unit. Higher oil recovery rates could be expected in greater slick thicknesses depending upon the pump selected. For example, in U.S. tests, a maximum of 5.9 m^3/h of oil was collected in calm conditions using a Wilden pump and the Skim-Pak.

OPTIMUM APPLICATION

In light to medium viscosity oils; in significant thicknesses (greater than 1 cm) concentrated by boom in calm or small wave, debris-free conditions; can be used from vessel or dock or where direct access may be space-limited.

FURTHER PERFORMANCE INFORMATION

(1) A Winter Evaluation of Oil Skimmers and Booms, Environmental Emergency Branch, Environment Canada, Ottawa, Ontario, (in preparation) (1981).

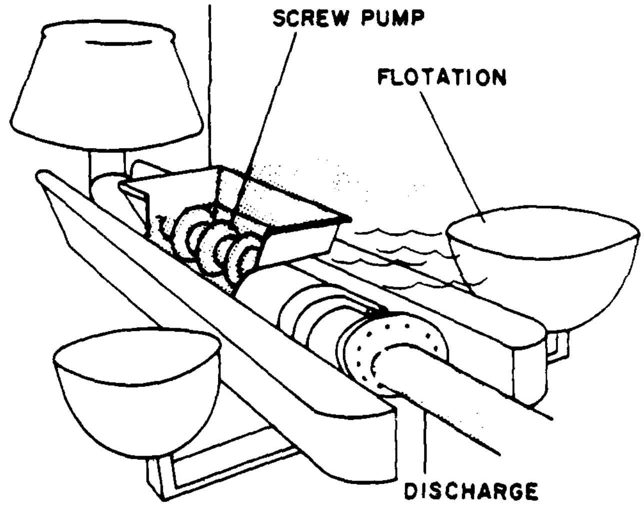
(2) Breslin, M.K. and H.W. Lichte, Performance Testing of Selected Skimmers Developed by Small Businesses, U.S. Environmental Protection Agency, Cincinnati, OH, (in preparation) (1980).

GUSTAF TERLING AB
P.O. Box 1013
S-43600 Askim
Sweden

DESTROIL

COLLECTION PRINCIPLE

Oil overflows a simple weir arrangement or hopper to feed an Archimedes screw pump positioned towards the bottom of the suction inlet. Product is then transferred directly upon its removal from the water's surface to storage or disposal facilities.



PHYSICAL SPECIFICATIONS

Three sizes of skimmer are available which incorporate the same collection principle.

	DS150	DS210	DS310
Skimming Head			
Length (cm)	203	254	356
Width (cm)	122	170	221
Discharge Hose Diameter (cm)	10.2	12.7	15.2-20.3
Weight (kg)	125-150	185-280	430
Materials of Construction	steel housing, aluminum suction inlet and floats (polyurethane-filled), bronze bearings		
Power Pack			
Length (cm)	122	160	200
Width (cm)	100	100	100
Height (cm)	110	110	110
Weight (kg)	600	800	1 000
Diesel Engine (kW)	10	20	30
	Deutz, air-cooled, four-stroke engine		
Hydraulic Pump	Cessna pressure/flow compensated axial pump		

MODE OF OPERATION

The skimming head is placed in a boomed-off area of concentrated oil and operated via its power pack and controls from a remote platform. Weir position can be adjusted by air feed into a flotation chamber on the skimmer from a compressor in the drive package. The Destroil and Troilboom (of Trelleborg AB, Sweden)

have been marketed as an advancing oil recovery system although both are also sold as separate items for more general application.

PERFORMANCE

Evaluation was undertaken in Canada in March 1980 and at OHMSETT in August 1979. The latter program included testing of the Destroil/Troilboom System and resulted in the following peak performance figures at a tow speed of 0.75 kn and maximum preload of 3.785 m^3 of oil:

For heavy oil (maximum viscosity 8.50 cm^2/s) in waves 0.26 m high x 4.2 m long:

Oil Content = 93%

Oil Recovery Rate = 20.9 m^3/h

For light oil, in calm conditions:

Oil Content = 91%

Oil Recovery Rate = 23.8 m^3

Maximum pumping rate was measured at 37.4 m^3/h and an upper tow speed limit determined to be 1 kn for oil retention without significant loss. The independent towing bridle allowed the boom to maintain a relatively constant waterline in waves while the total boom/skimmer system displayed good conformity in waves up to a 0.5 m irregular harbour chop.

Oil losses were approximately 227 m^3/h at 1 kn and 2 268 m^3/h at 1.2 kn; they were observed to be the result of vortex shedding near the side walls of the skimmer collection pocket. The processing of most forms of debris by the pump was possible.

In the Canadian tests, Bunker C was transferred by the Destroil at air temperatures of -5 to 0°C. Flow of the high viscosity oil to the pump was hampered by blockage due to the floats and difficulty was encountered in positioning the weir. If the weir was positioned too high, overflow of product did not occur; if too low, inflow of water flooded the intake. It was concluded, however, that oil that flowed and was present in sufficient thickness would not have presented these problems.

OPTIMUM APPLICATION

In light to very heavy oils (including Bunker fuels) contained in substantial thicknesses and in calm water; in all forms of debris (excluding rope); towed at 0.75 kn or less when used with Troilboom.

ADDITIONAL PERFORMANCE INFORMATION

(1) A Winter Evaluation of Oil Skimmers and Booms, Environmental Emergency Branch, Environment Canada, Ottawa, Ontario, (in preparation) (1981).

(2) Lichte, H.W., M.K. Breslin, G.F. Smith, D.J. Graham and R.W. Urban, Performance Testing of Four Skimming Systems, U.S. Environmental Protection Agency, Cincinnati, OH, (in preparation) (1980).

OTHER DATA

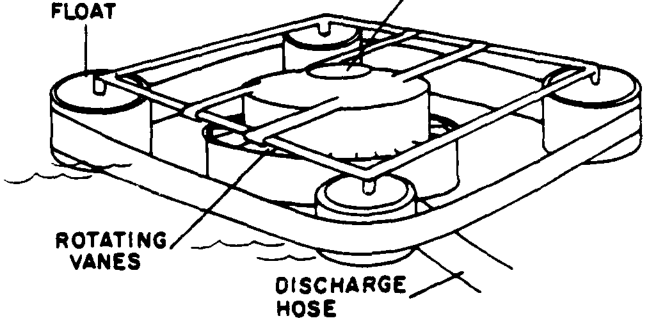
New lightweight skimmers have replaced older models. See Gustaf Terling AB GT-185 Oil Recovery System for details.

MATTSSON PRODUCKTER AB
PO Box 667
S-451 24 Uddevalla
Sweden

WALOSEP
(M.E.S.S.)

COLLECTION PRINCIPLE

A series of vanes rotate around a central stator drawing oil under it and up into a collection chamber. The oil overflows into a discharge hose and is pumped to remote storage while water exits the bottom of the skimming head.



PHYSICAL SPECIFICATIONS (standard model W3)

The system is sold as a three-component package:

	Skimmer	Pump Pack	Power Pack
Length (m)	2.71	1.10	1.50
Width (m)	2.29	1.00	0.80
Height (m)	1.07	1.50	1.50
Weight (kg)	400	1 400	1 600
Materials of Construction	stainless steel rotor, frame; glass-reinforced plastic stator; polyethylene floats		
Other Specifications		screw-type NE 80 BN3 hydraulically driven main pump (10.2 cm discharge hose); membrane-type LBBO hydraulically driven vacuum pump	Lister 3-cylinder air-cooled diesel rated at 44 HP at 2 200 rpm; PVB 29 hydraulic piston pump

MODE OF OPERATION

The skimming head is positioned in a boomed-off area of concentrated oil. The unit is then operated remotely using the power and pump packs. The membrane pump supplies the main screw pump with liquid prior to removal oı product by the latter. The system is designed for deployment from vessels and docks, with transfer of recovered oil made to prearranged storage facilities.

PERFORMANCE

In November 1979, the Walosep underwent a series of 19 tank trials at OHMSETT. Optimum results obtained were as follows:

Test Medium	Slick Thickness (mm)	Wave Height & Length (m)	Tow Speed (kn)	Oil Recovery Rate (m^3/h)	Oil Content (%)	Oil Recovered vs Oil Encountered (%)
heavy oil	50.1	0.32 x 6.17	0	54.6	97.7	100+
heavy oil	4.0	0.32 x 6.17	0.5	67.4	61.5	74.2
light oil	7.4	calm	0.5	68.6	80.0	50.9
light oil	4.8	0.49 x 17.57	0.7	97.0	78.0	58.8

The heavy and light test oils had specific gravities of 0.94 and 0.91, with viscosities of 23.0 and 0.55 cm^2/s at 10°C, respectively. A circular boom arrangement was used for stationary tests while a preloaded boom in a catenary shape was utilized for the tow trials.

One of the outstanding features of the Walosep skimmer was the relatively high oil content in the collected product in both light and heavy oil tests and in thin and thick slicks, particularly when compared with other nonsorbent-surface skimmers. The other noteworthy test result was the high oil recovery rates which peaked at 97 m^3/h in wave conditions while the skimmer was being advanced at 0.7 kn.

Oil losses were attributed to resonant waves washing over the skimmer. Generally, better results were obtained in thicker slicks, at higher pumping rates and with heavier oil. The lighter oil is more readily pumped but is also entrained at a faster rate.

Overall, the Walosep was concluded to be a high-capacity skimmer that could perform well in water currents below the failure velocity of booms.

OPTIMUM APPLICATION

In light to heavy oils (excluding non-flowing products); in calm to moderate sea conditions; in thicknesses of oil several millimetres and more contained by a boom; will process some debris.

ADDITIONAL PERFORMANCE INFORMATION

The OHMSETT work was performed under a private user agreement. Release of the data can be requested from the manufacturer.

OTHER DATA

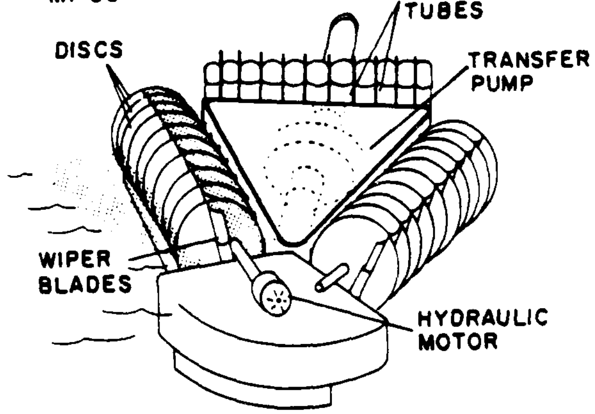
The manufacturer has indicated update of the W3 model with a heavier duty pump capable of processing debris and a submersible transfer unit. A lower-priced W1 skimmer is also available that utilizes a single pump/power pack; it has been designed for oil and chemical recovery.

MORRIS INDUSTRIES LTD.
1527 Columbia Street
North Vancouver, British Columbia V7J 1A3
Canada

MI-30
(Three-Square Skimmer)

COLLECTION PRINCIPLE

Three banks of 10 discs each rotate in oil which adheres to the discs and is scraped off by wiper blades. The oil flows down tubes into a central collection chamber. A pump internal to the skimmer's sump is then actuated to remove collected product to storage.



PHYSICAL SPECIFICATIONS

Overall Diameter (cm)	127
Overall Height (cm)	56
Draught (cm)	20
Disc Diameter (cm)	38
Discharge Hose Diameter (cm)	5.1
Weight (kg)	83
Materials of Construction	PVC discs, fibreglass-reinforced plastic body
Power Unit	Yanmar diesel 6 HP/hydraulic package
Transfer Pump	Granco positive displacement rotary type; 5.1 cm discharge port
Other Data	maintenance and repair kit, storage/transit cover, control package included

MODE OF OPERATION

The MI-30 can be launched by two persons. It is intended for operation within a containment barrier; disc speed and pumping are controlled through the remote power pack. Storage capacity must be prearranged.

PERFORMANCE

Testing of the MI-30 skimmer has seen a continuous upgrading of the product beginning with in situ trials conducted by Environment Canada and the Petroleum Association for Conservation of the Canadian Environment in the St. Lawrence River in October 1976 and progressing through to tank evaluations at OHMSETT in October 1978 and in Kanata, Ontario, in January 1979. The first Canadian tests yielded maximum recovery rates of 1 m^3/h of diesel and 0.7 m^3/h of crude oil in slick thicknesses of 9 and 10 mm, respectively. Lack of stability, coarse control of disc and pump speed, and the unit's centrifugal pump were

cited as factors adversely affecting performance. At OHMSETT, a skimmer with a positive displacement pump, improved control package and greater water planing capability (now standard features) was examined with maximum recovery rates of 1.7 m^3/h obtained for heavy oil and 4.8 m^3/h for light oil, both achieved in 11.5 mm slicks in calm water. Performance declined in wave conditions. Very similar results followed in the 1979 program, with oil content for both diesel and crude generally 96-99%. The power pack was operated outside the tank room at temperatures ranging from -15 to -25°C. Overall, the skimmer functioned well during the time evaluated.

Users report complete satisfaction with the unit. Recovery rates of 5 m^3/h and greater can be expected in slicks several centimetres in thickness. The hydraulic motors may require several hours of running during a "break-in" period before optimum performance is realized. The complete nature of the package and its versatility are cited by operators as the main reasons behind its popularity. The company has continued to improve the skimmer.

OPTIMUM APPLICATION

In light and medium viscosity oils; in significant concentrations of oil (1 cm and greater); in calm conditions; in a range of temperatures; will process oil in the presence of some debris.

ADDITIONAL PERFORMANCE INFORMATION

(1) Abdelnour, R. et al., Field Evaluation of Eight Small Stationary Skimmers, Technology Development Report EPS 4-EC-78-5, Environment Canada, Ottawa Ontario, (May, 1978).

(2) Abdelnour, R. et al., An Evaluation of Oil Skimmers and Pumps, Technology Development Report EPS 4-EC-81-4, Environment Canada, Ottawa, Ontario, (December, 1981).

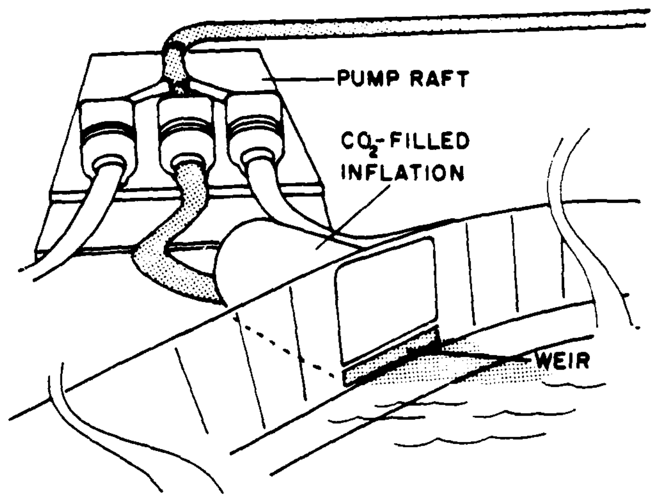
(3) Smith, G.F. and H.W. Lichte, Summary of US Environmental Protection Agency's OHMSETT Testing, 1974-1979, EPA 600/9-81-007, U.S. Environmental Protection Agency, Cincinnati, OH, (January, 1981).

OFFSHORE DEVICES, INC.
Building 43
Summit Industrial Park
Peabody, MA 01960
USA

HIGH SEAS SKIMMING AND PUMPING SYSTEM
(U.S. Coast Guard Skimming Barrier, VOSS)

COLLECTION PRINCIPLE

Product is concentrated by the boom which contains six weir components at its apex. As the barrier is advanced in a U-configuration, three pumps on a trailing platform are operated to transfer oil to storage/separation facilities. Outriggers and rigid panels provide stability.



PHYSICAL SPECIFICATIONS

Length (m)	187 (11 m of skimming section)
Total Height (cm)	122
Draught (cm)	69
Weight (kg/m)	23.8 (262 kg skimming section)
Shipping Weight (loaded) (kg)	7 000
Materials of Construction	elastomer-coated two-ply nylon, steel/ethafoam panels
Pumps	three double-acting diaphragm pumps, 10.2 cm discharge, 7.6 cm suction
Pump Float	3.28 m x 1.43 m x 0.91 m at 440 kg
Power Requirements	hydraulic drive 76 L/min at 1 360 kPa
Inflatable Floats	automatic CO_2 inflation system

MODE OF OPERATION

Two towing vessels take up either end of the Skimming Barrier and manoeuver it through a slick. The trailing pumps are operated from a remote position to transfer collected product to an attendant barge or other large-capacity craft. The system is stored in a container and self-inflates when removed for deployment. It was designed for offshore countermeasures operations.

A more recently marketed product includes 19.8 m of the Skimming Barrier and is called the Vessel of Opportunity Skimming System (VOSS). It is held by an outrigger boom at the side of a ship with product transferred by pump through a separator to on-board storage. All necessary components comprising the skimming package can be purchased (price: $137 000 (U.S.) effective 1-12-81).

PERFORMANCE

Extensive evaluation of the U.S. Coast Guard Skimming Barrier has been conducted. Test programs include work carried out at OHMSETT in 1975 and 1977 as well as sea trials in 1976 and 1981. OHMSETT data are reported for highest values of oil recovery rate and oil content.

Test Medium	Sea Conditions	Tow speed (kn)	Oil Recovery Rate (m^3/h)	Oil Content (%)
heavy oil	calm	0.74	87.4	83
heavy oil	28.7 cm wave	1.0	109.9	64
medium oil	calm	0.74	79.5	80
medium oil	calm	1.0	97.9	60

A preload of 19 m^3 was presented to 25 m of the boom towed in a catenary so that a 15 cm thickness of oil formed in front of the six weir components. Highest oil content measurements were noted in calm conditions at about 0.75 kn while oil recovery rates peaked at 1 kn. At higher tow speeds and in greater wave heights performance declined, particularly for the medium oil trials.

The seakeeping characteristics of the device were judged to be satisfactory; overall performance was very good at lower speeds and in calm and moderate wave conditions. The diaphragm pumps required various seal replacements but otherwise maintained high capacity transfer rates. The skimming barrier concept offers a very efficient use of the simple weir approach; when used as intended, it combines the basic countermeasures operations of oil containment and removal.

The VOSS package offers increased versatility in chasing down uncontained slicks. It also eliminates the need to purchase a costly hull, propulsion system and navigational equipment as part of the skimmer. The VOSS should display performance trends similar to the Skimming Barrier.

OPTIMUM APPLICATION

At tow speeds of 0.75-1 kn; in significant concentrations of oil so that 10-20 cm of oil can be accumulated at the weir inlets; in calm and moderate sea states; will process some debris.

ADDITIONAL PERFORMANCE INFORMATION

(1) Lichte, H.W., Skimming Barrier Performance Evaluation: Offshore Version and Harbour Version, 1979 Oil Spill Conference, Los Angeles, CA, (1979).

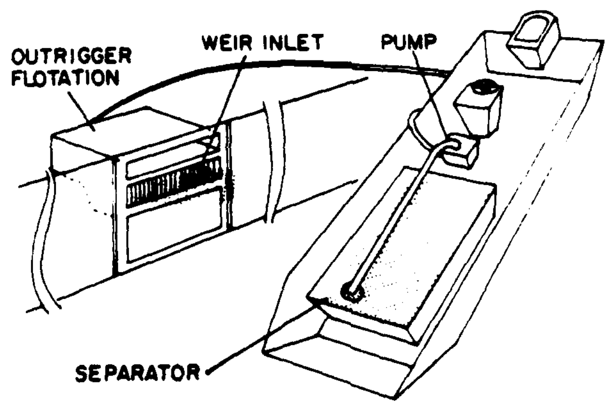
(2) Lichte, H.W. and M.K. Breslin, Performance Testing of Three Offshore Skimming Devices, EPA 600/7-78-082, U.S. Environmental Protection Agency, Cincinnati, OH, (1978).

OFFSHORE DEVICES, INC.
Building 43
Summit Industrial Park,
Peabody, MA 01960
USA

SCOOP

COLLECTION PRINCIPLE

Product concentrated by a boom overflows two or four simple weir sections incorporated in the boom structure and located at its apex. The liquid is then pumped to a separator tank from which water is discharged; concentrated oil is transferred to separate storage facilities. Boom stability is provided by rigid panels and outrigger floats.



PHYSICAL SPECIFICATIONS

	Barrier	Vessel	Separator
Length (m)	20.7	9.1	1.47
Width	--	2.4	1.07
Height (m)	0.61		1.22
Draught (cm)	34	38	--
Capacity (L)	--	--	1 325
Weight (kg)	238	varies with power option	238 (empty)
Materials of Construction	elastomer-coated nylon; aluminum stiffness; ethafoam flotation; lead ballast	fibreglass, foamcore sides	aluminum or fibreglass; sight glass
Weir Opening	43 cm x 6 cm		
Propulsion	170 HP gasoline inboard/outboard engine, optional twin outboard motors		
Vessel Speed	2.5 kt (depends on power mode selected)		
Pump	double acting diaphragm, hydraulically driven, 7.6 cm suction and 10.2 cm discharge ports, 45 kg cast aluminum housing		
Other Data	also includes two 1 895 L rubber storage bladders		

MODE OF OPERATION

The SCOOP Vessel can be trailered and launched via ramp or crane. It, along with a second craft, tow either end of the boom in a catenary to contain and concentrate free-floating slicks. Once liquid has been collected and pumped to the separator where water is removed, the oil is transferred to a towed bladder. Deployment and retrieval of the barrier can be quickly accomplished by two persons. Use is intended for lakes, harbours and other more sheltered waterways.

PERFORMANCE

Both *in situ* and tank evaluations have been conducted of the SCOOP system. The former was undertaken on behalf of Environment Canada near Annapolis, Maryland, in August 1978 and the latter in May of the same year. Separate testing of the pump and separator components has also been documented.

At OHMSETT, numerical data were also recorded for the system as a whole with the following optimum results.

Heavy Oil Tests (7.00 cm^2/s at 28.8°C; S.G. 0.936)

	Tow Speed (kn)	Wave Height x Length (m)	Separator Flow Rate (m^3/h)
Oil Recovered vs Oil Encountered = 100%	0.75	0.6 Harbour Chop	22.7
Oil Content = 100%	1.0	0	49
Oil Recovery Rate = 11.5 m^3/h	0.75	0.3 x 9	15.5

In light oil tests, best results were obtained in calm conditions at tow speeds of 0.75 kn; specifically, Oil Recovered vs Oil Encountered was 89%, Oil Content was 26% and Oil Recovery Rate was 7.6 m^3/h measured at separator flow rates of 11.9, 36.4 and 19.8 m^3/h, respectively. Examination involved the presentation of about 1 m^3 of oil rather than the 4 m^3 projected by the test team to fully load the barrier. The separator nominal design flow rate of 13.6 m^3/h was exceeded with excellent results in the heavy oils while the efficient processing of light oil required staying within design criteria.

Comprehensive testing has also shown operating limits to depend on pump capacity and boom tow speed. The pumping rates achieved were 51 m^3/h for pure oil with a viscosity of 7.00 cm^2 at 28.8°C; oil retention at speeds up to 1.25 kn was possible although results were inconclusive.

The manufacturer has incorporated several design changes (partially as a result of the various test programs) and has constantly upgraded the product. Improved hydraulic controls and vessel stability, a strengthened vent stand pipe on the separator, as well as a number of available options have increased the effectiveness of the SCOOP.

Overall, the Canadian test team found the system to be highly manoeuverable and the boom and weirs to be stable.

OPTIMUM APPLICATION

In light and medium viscosity oils; in calm conditions; at tow speeds of about 0.75 kn; in debris-free water; with significant concentrations of oil (at least several centimetres).

ADDITIONAL PERFORMANCE INFORMATION

(1) Abdelnour, R. et al., An Evaluation of Oil Skimmers and Pumps, Technology Development Report EPS 4-EC-81-4, Environment Canada, Ottawa, Ontario, (December, 1981).

(2) Graham, D.J., R.W. Urban, M.K. Breslin and M.G. Johnson, OHMSETT Evaluation Tests: Three Oil Skimmers and a Water Jet Herder, EPA 600/7-80-220, U.S. Environmental Protection Agency, Cincinnati, OH, (1980).

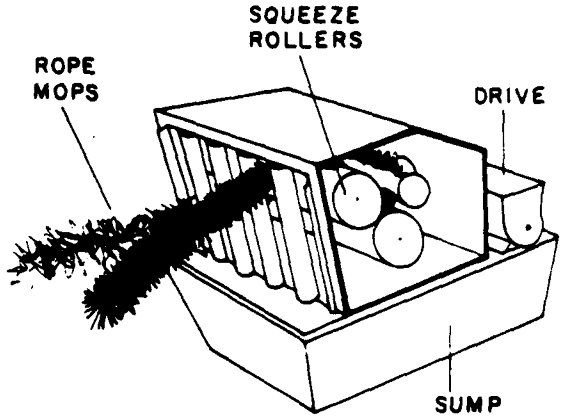
OIL MOP, INC.
Engineers Road
P.O. Drawer P
Belle Chasse, LA 70037
USA
(For UK information see preceeding entry)

telephone (504) 394-6110
telex 58 7486

Mk I, II, IV Series
Mk I-4
Mk II-4
Mk II-9D
Mk IV-16DP

COLLECTION PRINCIPLE

Oil preferentially adheres to an endless woven rope mop which is pulled and wrung by a roller/drive assembly. The end of the mop remote from the power source passes around one or more anchored tail pulleys. Collected product drops into a sump from which it is pumped to storage.



PHYSICAL SPECIFICATIONS (E-electric; D-diesel)

	Mk I-4E	Mk I-4D	Mk II-4E	Mk II-4D	Mk II-9D	Mk IV-16DP
Length (cm)	104	104	79	114	183	305
Width (cm)	48	55	31	64	112	227
Height (cm)	51	81	39	81	130	215
Storage Capacity (L)	—	—	—	175	684	3 657
Dry Weight (kg)	86	106	34	204	725	3 600
Materials of Construction	polypropylene fibre rope mop, steel wringer housing, neoprene rollers					
Maximum Mop Length (m)	75	76	7.6	91	610	610
Diameter (cm)	10.2	10.2	10.2	10.2	10.2	23
Power Requirement (continuous HP)	0.5	4.1 @ 3 600 rpm	two fractional HP motors 115 V, 60 Hz	3.5 @ 3 600 rpm	6.5 @ 3 600 rpm	37.5 @ 1 800 rpm
Mop Speed (m/min)	14	14-19	12.5	14.33	21.42	0-45
Pump	in Mk II and IV series only; varies in size up to the 7.6 cm centrifugal trash pump in the Mk IV					

The Mk II series skimmers have optional 115/230 V, 60 Hz single-phase drives with reduced continuous horsepower.

MODE OF OPERATION

The power/wringer unit can be operated from any suitable working platform or from shore to take up previously contained and concentrated oil. Diesel units incorporate a clutch for wringer activation; the drive mechanism varies in different models. Electric units require an external power source.

PERFORMANCE

In Canada, in situ testing of the Mk II-9 was conducted in 1975 followed by its examination with an electric preheater in 1977. Tests have also been carried out at Warren Spring Laboratory in the UK and at OHMSETT in the U.S.

Optimum Results Mk II-9D (*U.S. trials)

Sea Conditions	Test Medium	Viscosity (cm^2/s)	Thickness (mm)	Oil Recovery Rate (m^3/h)	Oil Content (%)
10-15 cm waves	crude oil	0.06 at 37.8°C	5	2.3	71.5
10-15 cm waves	emulsion	22.27 at 20°C	5	0.5	77
calm*	diocytl phthalate	0.792 at 16°C	--	10.0	98.3

With a 200 kW preheater, the Mk II-9D recovered Bunker C at a rate of 0.6 m^3/h from a boomed-off area in the St. Lawrence River. When applied at OHMSETT as a Vessel of Opportunity Skimmer System (VOSS) or "over-the-side" concept in July 1978, oil recovery rates peaked at 11.1 m^3/h in heavy oil in a 0.6 m harbour chop and at 14.8 m^3/h in light oil in calm conditions using two mops. Tow speeds were 1.5 and 3.0 kn, respectively; maximum oil content was 68% in heavy oil and 48% in light oil. Performance has been found to be sensitive to oil viscosity and rope mop speed and is less affected by debris and wave conditions. Transfer time of oil to rope increases with viscosity although more viscous products generally result in a higher oil content in the collected liquid. Improved rollers and pump selection have added to the machine's capability; users generally report successful application in spills of a range of oils. Past problems of drum scoring and emulsification are largely overcome.

OPTIMUM APPLICATION

In light to heavy viscosity oils excluding non-flowing products; in calm and moderate wave conditions; in thicknesses of oil several millimetres and more; in many forms of debris.

ADDITIONAL PERFORMANCE INFORMATION

(1) Graham, D.J., R.W. Urban, M.K. Breslin and M.C. Johnson, OHMSETT Evaluation Tests: Three Oil Skimmers and a Water Jet Herder, EPA 600/7-80-020, U.S. Environmental Protection Agency, Cincinnati, OH, (1980).

(2) McCracken, W.E. and J.H. Schwartz, Performance Testing of Spill Control Devices on Floatable Hazardous Materials, EPA 600/2-77-222, U.S. Environmental Protection Agency, Cincinnati, OH, (1977).

(3) Solsberg, L.B. et al., Field Evaluation of Seven Oil Spill Recovery Devices, Technology Development Report EPS 4-EC-76-3, Environment Canada, Ottawa, Ontario, (October, 1976).

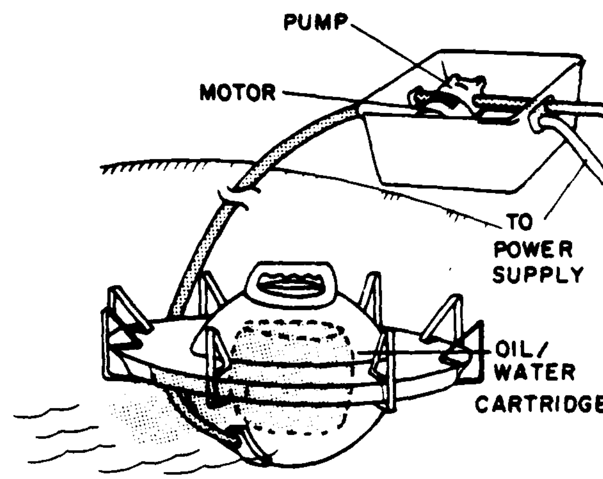
(4) Thomas, D.H., Evaluation Trials on Equipment Manufactured by OMI Ltd., Tonbridge, Kent, The Oil Mop Mark II-9DP, Warren Spring Laboratory, Stevenage, UK, (1978).

(5) Tidmarsh, G.D. and L.B. Solsberg, Field Evaluation of Oil Mop and Preheat Unit, Technology Development Report EPS 4-EC-77-12, Environment Canada, Ottawa, Ontario, (November, 1977).

OIL RECOVERY SYSTEMS, INC **SCAVENGER**
Main Street
Greenville, NH 03048
USA

COLLECTION PRINCIPLE

An oil/water separator cartridge allows the ingress of oil into a central sump. A level control automatically activates a remote pump to transfer product.



PHYSICAL SPECIFICATIONS

Diameter (cm)	44.5
Height (cm)	24.1
Draught (cm)	12.7
Discharge Hose Diameter (cm)	1.9
Weight (kg)	5
Materials of Construction	PVC body, fibreglass case
Drive	1/4 HP, 115 V AC, 4.2 A, 172 rpm explosion-proof motor
Pump	Roper 2 AMO3 pump with strainer
Other Data	the total system weighs 52 kg and is contained in a cubic case measuring 61 cm across. Various cartridges are available for different oil types

MODE OF OPERATION

The Scavenger was designed for well, ditch and groundwater oil recovery or other situations in which it can collect a seepage of oil over an extended period of time. Automatic pumping and shut-off systems allow for unattended skimming. The skimmer is highly portable; storage capacity must be preplanned and a power source secured.

PERFORMANCE

The Scavenger was evaluated on behalf of Environment Canada and the Petroleum Association for Conservation of the Canadian Environment during October 1976 in the St. Lawrence River at Quebec City. The following optimum results were obtained using diesel oil:

Air Temp. (°C)	Water Temp. (°C)	Wave Height (cm)	Oil Thickness (mm)	Oil Recovery Rate (L/min)	Oil Content (%)
10	12	0	4	0.47	100
12	12	0	10	0.38	100

This well-engineered, carefully constructed skimmer functioned as designed in both automatic and manual control modes. Comprehensive instructions allow its operation by untrained personnel. Recovery rate is relatively low as designed; however, product purity is high. Wave action results in a rolling movement of the skimmer which reduces efficiency.

Although not available at the time of testing, other cartridges should permit the recovery of a range of oil viscosities.

The skimmers has been widely applied to a variety of groundwater contamination problems and users report satisfaction with its performance. In particular, its small size has permitted access to difficult-to-reach places (wells, sewers, etc.) and prolonged skimming has been successfully conducted using the Scavenger without operator supervision.

OPTIMUM APPLICATION

In very light to medium viscosity oils that are contained or slowly accumulated; in calm, debris-free conditions; where access is limited and/or prolonged recovery of minor amounts of oil is required; will function in several millimetres of product.

ADDITIONAL PERFORMANCE INFORMATION

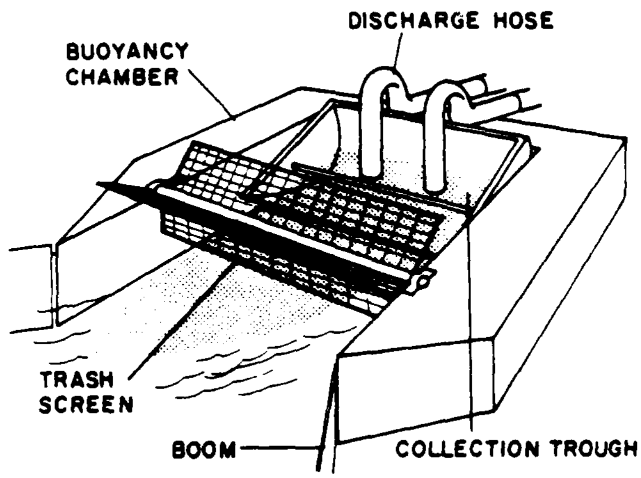
Abdelnour, R. et al., Field Evaluation of Eight Small Stationary Skimmers, Technology Development Report EPS 4-EC-78-5, Environment Canada, Ottawa, Ontario, (May, 1978).

PEMBINA EQUIPMENT DESIGN CO. LTD.
P.O. Box 1994
Drayton Valley, Alberta T0E 0M0
Canada

PEDCO SKIMMER

COLLECTION PRINCIPLE

Two pontoons support between them a self-levelling weir over which product flows. The product collects in a trough which forms the aft section of the weir, and from there is transferred to storage by remote pump.



PHYSICAL SPECIFICATIONS

	Four-Foot Model (1.2 m)	Eight-Foot Model (2.4 m)
Overall Length (m)	1.68	1.68
Overall Width (m)	1.96	3.15
Overall Height (m)	0.79	0.79
Weir Width (m)	1.22	2.43
Draught (cm)	10	10
Suction Hose Diameter (cm)	7.6	unspecified
Weight (kg)	55	83
Material of Construction	aluminum in both models	
Debris	unique three-sided screen available	

MODE OF OPERATION

The PEDCO skimmers function in either stationary or flowing conditions. In the case of the latter, booms attach to either side of the unit and direct product into the weir. The pumping rate determines the angle at which the collection trough sits so that either more or less oil is removed (depending on slick thickness). Storage/separation facilities should be planned.

PERFORMANCE

Testing of the Four-Foot PEDCO was undertaken in October 1976 in the St. Lawrence River on behalf of Environment Canada and the Petroleum Association for Conservation of the Canadian Environment. Optimum results were as follows:

Air Temp. (°C)	Water Temp. (°C)	Wave Height (cm)	Current (kn)	Oil Type	Oil Thickness (mm)	Oil Content (%)	Oil Recovered vs Oil Encountered (%)
15	14	0	0.5	crude	14	21.6	94.2
16	13.5	0	0.8	diesel	1	4.4	28.2
16	14	0-3	0.9	emulsion	5	10.2	6.6

Crude: Iranian, API Gravity 30° to 43°

Diesel: blend, 0.020 to 0.043 cm^2/s at 15°C

Testing clearly demonstrated that the PEDCO functions best when encountering a substantial thickness of oil at a rate that is matched by the off-loading pumping rate. It is also evident that the machine can be used most effectively in calm, flowing conditions. Performance declines in slick thicknesses of only several millimetres and in waves that are 5-10 cm in height. Evaluation results suggest that oil/water separation and storage facilities are required for skimming a layer of oil less than 1-2 cm thick.

The main oil loss mechanism was attributed to underflow of the product resulting from the back buoyancy chamber being perpendicular to flow, and to excessive oscillation of the collection trough in wave conditions. These are factors which can largely be overcome by applying the device in limited wave and current situations. In the prototype device tested, it was apparent that ultimate fabrication processes, choice of tethering, lifting and connection hardware, as well as ballasting arrangements, had still to be selected.

Overall, this lightweight skimmer with one moving part seems to be ideally suited for the removal of spilled oil in rivers once sizing requirements have been clarified by the purchaser. Recovery rates will depend on the choice of pump.

OPTIMUM APPLICATION

In light and medium viscosity oils several centimetres in thickness; used in calm, flowing conditions in conjunction with booms; will process some debris; follow up with separation/storage capacity.

ADDITIONAL PERFORMANCE INFORMATION

Solsberg, L.B., W.G. Wallace and M.A. Dunne, Field Evaluation of Oil Spill Recovery Devices: Phase Two, Technology Development Report EPS 4-EC-77-14, Environment Canada, Ottawa, Ontario, (December, 1977).

OTHER DATA

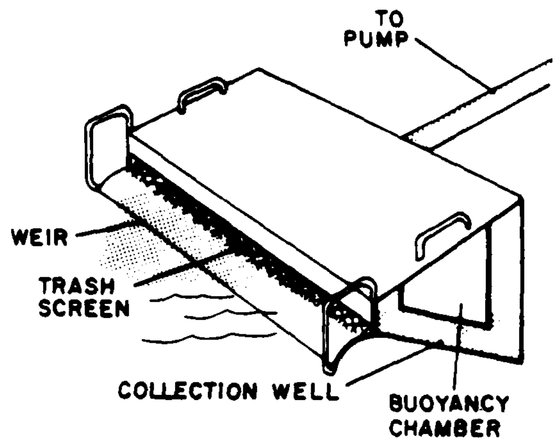
A Two-Foot (0.6 m) PEDCO Ice Slot Skimmer has also been successfully tested in the recovery of oil from a slot cut in river ice. In addition, the company now markets the Mini Pedco which can be deployed in water, is also 0.6 m in width, and weighs 39 kg.

SEAWARD INTERNATIONAL INC. **SLURP**

6269 Leesburg Pike
Falls Church, VA 22044
USA

COLLECTION PRINCIPLE

The Self-Levelling Unit for Removing Pollution (SLURP) incorporates a hydro-adjustable weir over which oil flows into a collection well. A remotely positioned pump controls the immersion depth of the weir and the collection rate.



PHYSICAL SPECIFICATIONS

	Aluminum	Stainless Steel
Length (cm)	93.5	93.5
Width (cm)	66.2	66.2
Height (cm)	26.7	38.1
Approx. Draught (cm)	12	25
Weight (kg)	16	26
Discharge Hose Diameter	3.8 cm (5.1 cm discharge port)	
Pump Unit	3.8 cm self-priming centrifugal pump, either electric powered or driven by a 3 HP Briggs & Stratton gasoline engine, is available	
Debris	screen outfitted	
Other Options	6 m positioning wand, debris fence, oil/water separator, collapsible storage container, etc.	

MODE OF OPERATION

The SLURP was designed for quick deployment into stationary, concentrated slicks. Collection rate is usually controlled by pump speed and a valve on the suction line. Single person deployment is possible; however, subsequent oil/water separation should be planned.

PERFORMANCE

Developed by the Esso Research Centre in the UK, a SLURP skimming head and a 7.6 cm Spate (induced flow) pump driven by a 3 HP Petter diesel were tested in situ on behalf of Environment Canada in early 1975. Optimum results obtained were as follows:

Air Temp. (°C)	Water Temp. (°C)	Wave Height (cm)	Test Medium	Oil Thickness (mm)	Oil Recovery Rate (m^3/h)	Oil Content (%)
3.2	1.5	10-15	crude	5	0.47	15.3
3.2	1.8	0	emulsion	10	1.42	23.7

Crude: Arabian, API Gravity 33.5°; viscosity 0.0604 cm^2/s @ 37.80°C

Emulsion: 70.5% water; viscosity 8.80 cm^2/s @ 20°C

The sea trials indicated the SLURP to be more effective in recovering thicker slicks of 1 cm and greater. The device functioned equally well in calm and moderate wave conditions although mixing of oil and water in the collection well was noted in waves. Subsequent emulsification of the oil and water was attributed to the action of the pump.

It was also noted that a more continuous procedure was possible with an oil that readily overflowed the weir. Otherwise, the thicker oil was not drawn away at a constant rate with the result that the weir immersed repeatedly to accept the underlying water. Operating limitations also related to the up and down (porpoising) motion of the skimmer due to excessively high pumping rates and a stiffened discharge hose at the temperatures tested.

Overall, the SLURP was determined to be a low-cost, portable unit capable of operating over a limited range of wave conditions but with a tendency to collect a relatively stable mixture of oil and water. As now marketed, the wider choice of pumps, inclusion of control valve, addition of quick-disconnect fittings and PVC-nitrile hose should provide improved performance.

OPTIMUM PERFORMANCE

In lighter oils contained in thicknesses of 1 cm and greater; in debris-free conditions; operated with pump that minimizes mixing at rates that allow smooth, continuous oil collection and discharge; followed by oil/water separation.

ADDITIONAL INFORMATION

(1) McCracken, W.E., Performance Testing of Selected Inland Oil Spill Control Equipment, EPA 600/2-79-150, U.S. Environmental Protection Agency, (1977).

(2) Solsberg, L.B. et al., Field Evaluation of Seven Oil Spill Recovery Devices, Technology Development Report EPS 4-EC-76-3, Environment Canada, Ottawa, Ontario, (October, 1976).

OTHER DATA

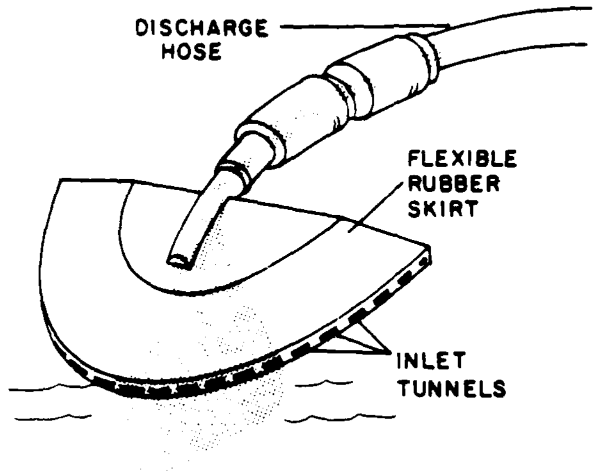
The SLURP was evaluated at OHMSETT in May 1975 with numerical results reported similar to those noted in the Canadian field trials.

SLICKBAR, INC.
250 Pequot Avenue
Southport, CT 06490
USA

FLEXIBLE MANTA RAY

COLLECTION PRINCIPLE

A series of rectangular tunnels in a floating suction head allow the ingress of product which flows to a central discharge hose through which it is conveyed to storage by remote pump.



PHYSICAL SPECIFICATIONS

Weir Length (cm)	152
Tunnel Openings (two sizes)	1.3 cm and 2.5 cm x 1.3 cm
Draught (cm)	7.6
Discharge Hose Diameter (cm)	7.6
Weight (kg)	26.3
Material of Construction	flexible nitrile rubber
Maximum Design Vacuum Pressure	51 kPa
Pump Unit	skimmer head compatible with company's Slickskim Model 60 unit 7.5 HP gasoline engine-driven single diaphragm pump; Model 160 system 3.6 HP diesel engine or equivalent gasoline/electric motor and double-diaphragm pump; and Trans-vac 500-D 40 HP diesel-driven vacuum pump, separator and rotary discharge pump.

MODE OF OPERATION

The skimmer is designed for deployment into a stationary slick contained and concentrated by a boom. A remotely located pump is used to withdraw oil through the floating suction head. The company's largest pumping system allows multiple unit hook-up and provides oil/water separation. Manual launching by a single person is easily accomplished.

PERFORMANCE

Evaluation of the Manta Ray Flexible Skimmer has been conducted both as tank tests in May 1975 at OHMSETT and in situ in October 1977 in the St. Lawrence River on behalf of Environment Canada and the Petroleum Association for Conservation of the Canadian Environment.

Optimum Canadian Test Results (2.5 cm opening model)

Air Temp. (°C)	Water Temp. (°C)	Wave Height (cm)	Test Medium	Oil Thickness (mm)	Oil Recovery Rate (m^3/h)	Oil Content (%)
12	12	0	crude	3	0.29	3.4
12	12	0	crude	10	1.33	10.4
8	12	0	diesel	3	0.36	3.6
10	12	0	diesel	10	1.00	10.6

Optimum U.S. Test Results (2.5 cm opening)

Air Temp. (°C)	Water Temp. (°C)	Wave Height (cm)	Test Medium	Oil Thickness (mm)	Oil Recovery Rate (m^3/h)	Oil Content (%)
24	20	30	lube	25.4	3.1	20.4
32	25	0	lube	25.4	2.5	61.9

Optimum U.S. Test Results (1.3 cm opening)

Air Temp. (°C)	Water Temp. (°C)	Wave Height (cm)	Test Medium	Oil Thickness (mm)	Oil Recovery Rate (m^3/h)	Oil Content (%)
21	20	60	lube	25.4	4.5	37.5
25	20	30	lube	25.4	2.6	68.6

crude: Iranian, viscosity 58 SSU @ 37.8°C; API Gravity 30.0°

diesel: viscosity 1.90 SSU @ 37.8°C; API Gravity 40.0°

pump: 7.6 cm induced-flow Spate unit in Canadian tests; Marlow self-priming double-diaphragm in U.S. tests

lube oil: viscosity 2.72-3.30 cm^2/s at test temperatures

The U.S. and Canadian test programs clearly illustrate that recovery capacity for this skimmer depends upon slick thickness. Both recovery rate and oil content improve markedly in slick thicknesses of 1 cm, with the latter particularly higher in calmer conditions. The Canadian tests further demonstrated that deployment in one orientation maximized oil entry. Overall, the skimmer has been found to be well constructed, easy to use, and requires no adjustments for operation. Provision for debris is not included.

OPTIMUM APPLICATION

In light to medium viscosity oils; in debris-free conditions; in calm water; in oil thicknesses 1 cm and greater.

ADDITIONAL PERFORMANCE INFORMATION

(1) Abdelnour, R. et al., Field Evaluation of Eight Small Stationary Skimmers, Technology Development Report EPS 4-EC-78-5, Environment Canada, Ottawa, Ontario, (May, 1978).

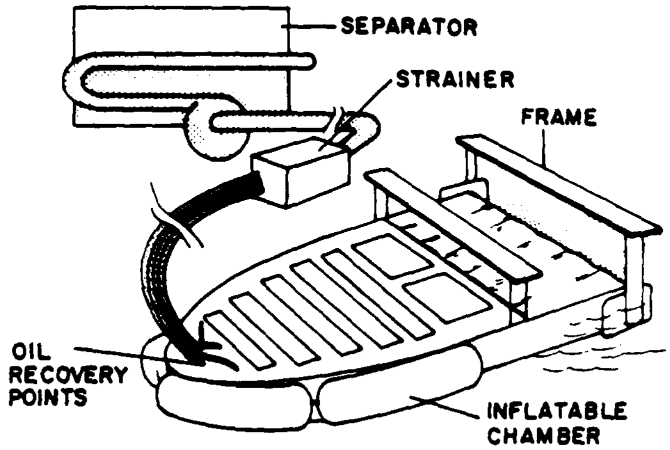
(2) McCracken, W.E., Performance Testing of Selected Inland Oil Spill Control Equipment, EPA 600/2-77-150, U.S. Environmental Protection Agency, (1977).

TRACOR MARINE
P.O. Box 13107
Port Everglades Station
Fort Lauderdale, FL 33316
USA

SOCK
((Shell) Spilled Oil
Containment Kit)

COLLECTION PRINCIPLE

Oil and water enter an open-bottom chamber which floats on the surface as a semi-ellipsoid shape. Product concentrating at the aft end is pumped to a remotely positioned separator for further water removal and the oil then transferred to storage. An in-line strainer removes debris.



PHYSICAL SPECIFICATIONS (1980 test kit)

Length (m)	8.84
Width (m)	2.44
Discharge Hose Diameter	three @ 7.6 cm each
Weight (skimmer only) (kg)	2 948
Materials of Construction	nylon reinforced nitrile rubber, aluminum frame
Air Tuggers	two @ 1 m x 1 m, each @ 90.7 kg
Tool House	2.1 m x 3.7 m @ 2 268 kg
Power Unit	60 HP air-cooled diesel engine
Pump	Tuthill positive displacement
Debris	fluids strainer/manifold, 1 m x 1 m @ 90.7 kg
Other Features	42 longitudinal, 32 transverse flotation cells

MODE OF OPERATION

The SOCK was designed for use in conjunction with an offshore vessel. The flexible chamber streams from a floating frame which is in turn towed alongside a vessel advancing through an uncontained slick. As originally conceived, launching apparatus as well as a diesel/hydraulic power source, pump, separator and auxiliary equipment comprise the skimming package. When not deployed, on-board storage of all skimming components is possible. Original installation of all equipment on a vessel may take 1 to 2 days, requires substantial lifting capacity, but is straightforward under good supervision.

PERFORMANCE

Offshore testing of the SOCK was sponsored by the U.S. Navy and conducted in April 1980 in the Atlantic Ocean off New Jersey. Results were recorded as follows for Larosa (Venezuelan) crude, API gravity 23.9°.

Wave Height (m)	Wave Period (s)	Direction to Sea	Forward Speed (kn)	Oil Recovery Rate (m^3/h)	Oil Content (%)	Oil Recovered vs Oil Encountered (%)
1.2	7	lead	1.0	10	44	55
0.9	5.5	lead	1.3	35	89	93
1.4	3.7	lead	1.3	12	39	47
1.0	4.3	follow	1.75	12	43	43
0.7	5.8	follow	2.1	2	26	18

The wave height and period indicated are 1/3 significant. Water temperature was constant at 6.7°C, with air temperatures varying between 8.3 and 11.1°C.

Highest recovery figures were measured at a relative wind-driven surface (oil) velocity of 1.5 kn in 1 m waves, 5 s peak to peak. About 35 m^3/h of a 2 mm slick were recovered. Performance was generally found to decline in rougher seas and at higher velocities. Loss mechanisms were attributed to shedding and entrainment, with vortices and turbulence generated by the system apparent at speeds greater than 1 kn. It was further determined that the capability of the mother ship to (a) maintain slow speeds with a steady heading and (b) otherwise manoeuver with a low-drag force device towed alongside was critical to machine performance.

OPTIMUM APPLICATION

Likely in light to medium viscosity oils at relative velocities of approximately 0.75 kn and lower; in concentrations of oil several millimetres thick and more; in debris-free conditions; in calm and moderate sea conditions including ocean swells.

ADDITIONAL PERFORMANCE INFORMATION

(1) Ayers, R.R., SOCK-An Oil Skimming Kit for Vessels of Convenience, 1977 Oil Spill Conference, American Petroleum Institute, New Orleans, LA, (March 8-10, 1977).

(2) Lichte, H.W., M. Borst and G.F. Smith, USNS Powhatan, SOCK Skimmer Offshore Tests, U.S. Environmental Protection Agency, Cincinnati, OH (in preparation).

(3) Lichte, H.W., M. Borst and G.F. Smith, USNS Powhatan, SOCK Skimmer Offshore Tests, Proceedings of the 1981 Oil Spill Technology Conference, American Petroleum Institute, Atlanta, GA, (March, 1981).

OTHER DATA

The SOCK was originally developed by Shell Development Company and later with the assistance of the Gulf of Alaska Clean-up Organization.

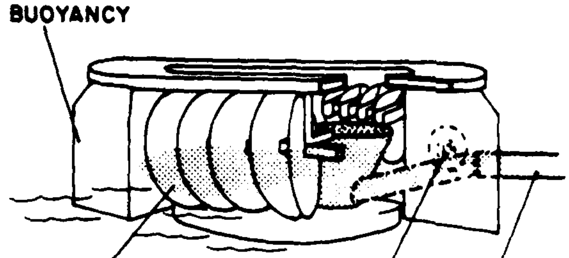
Shell Development Company,
E-1340 Westhollow Research Center,
P.O. Box 1380,
Houston, TX 77001
USA

VIKOMA INTERNATIONAL, LTD.
Littleton House
Littleton Road
Ashford, Middlesex TW15 1UQ
England

KOMARA MINISKIMMER
(Komara 12K Skimmer)

COLLECTION PRINCIPLE

Thirty-two plastic discs rotate along the periphery of a circular floating head to take up floating oil. The product is scraped from the discs and enters a central sump from which it is pumped to storage by a remotely located transfer unit.



PHYSICAL SPECIFICATIONS

Maximum Width (m)	1.16
Overall Height (cm)	46
Draught (cm)	19
Discharge Hose Diameter (cm)	7.6
Weight (kg)	54.4
Disc Diameter (cm)	28
Materials of Construction	plastic, foam-filled buoyancy chambers
Power & Transfer Unit	diesel/hydraulic pump package includes single cylinder Petter engine, Spate induced-flow 7.6 cm pump, hydraulic pump, controls; weight 182.3 kg

MODE OF OPERATION

The skimmer is deployed into a contained slick; disc speed and pumping are controlled through the remotely placed power pack. Launching can be readily accomplished by two persons with operation taking place from a wharf, shoreline, vessel or other suitable working platform. Storage for collected product must be prearranged.

PERFORMANCE

The Komara was evaluated in situ in October 1976 under the direction of Environment Canada and in tank trials at OHMSETT in June 1975 and May 1976.

Air Temp. (°C)	Water Temp. (°C)	Wave Height (cm)	Test Medium	Disc Speed (rpm)	Slick Thickness (mm)	Oil Recovery Rate (m^3/h)	Oil Content (%)
Optimum U.S. Test Results							
24	26	0	No. 2 Fuel	--	25.4	2.4	99+
--	--	0	Light Oil	139	23	0.59	43.1
--	--	0	Light Oil	58.9	5.3	0.25	71.9

No. 2 Fuel: 0.18 cm^2/s @ 26°C

Light Oil: 0.10 cm^2/s @ 38°C

Air Temp. (°C)	Water Temp. (°C)	Wave Height (cm)	Test Medium	Disc Speed (rpm)	Slick Thickness (mm)	Oil Recovery Rate (m^3/h)	Oil Content (%)
Optimum Canadian Test Results							
5	8.5	0	Crude Oil	--	10	2.2	84
4	8.5	0	Diesel	--	10	0.96	98

Crude Oil: Iranian, API Gravity 30°-43°

Diesel: blend, 0.024-0.043 cm^2/s at 15°C

The Komara has been determined to perform consistently well in test programs. The skimmer will tolerate moderate size waves (10-20 cm) and generally collects oil with a lower water content at relatively lower disc speeds. Pickup rate tends to increase with increasing slick thickness and viscosity although heavier oils cannot be processed by the disc/scraper system and remote pump.

Environment Canada noted the Komara to be a lightweight, easily handled system that was capable of "pulling in" product with consistently high oil content. Modifying features secondary to the main collection component were cited as offering further improvement including the use of rigid hose material, quick-disconnect fittings, more durable body and improved wiper contact.

OPTIMUM APPLICATION

In calm to very moderate sea conditions; in light and medium viscosity oils contained in thicknesses of several millimetres and more; will process some debris; optimally operated at less than maximum disc rpm.

ADDITIONAL PERFORMANCE INFORMATION

(1) McCracken, W.E., Performance Testing of Selected Inland Oil Spill Control Equipment, EPA 600-2-77-150, U.S. Environmental Protection Agency, Cincinnati, OH, (August, 1977).

(2) Solsberg, L.B., W.G. Wallace and M.A. Dunne, Field Evaluation of Oil Spill Recovery Devices: Phase Two, Technology Development Report EPS 4-EC-77-14, Environment Canada, Ottawa, Ontario, (December, 1977).

(3) Widawsky, A., Performance Tests of Three Skimmers and One Boom at OHMSETT, TM-60P-76-11, U.S. Naval Civil Engineering Laboratory, (1976).

Appendix B

Table 7-1

Oil Spill Skimmer Performance (1)

Manufacturer	Location	Type(2) Skimmer	Recovery(3) Rate Bbl/day	Wave Limit Ft.	Wind Limit Kt.	Skimming Speed Kt.	Test Film Thickness mm.	Skimming Width Ft.	Cost Kdol	Tested at
A/S DeSmithske	Denmark	Weir (Destroil Skimmer)	1,300	8	21	.75	--	10	94.4	OHMSETT Burmah Agate
Frank Mohn	Norway	Weir/Disc (Arctic Skimmer)	2,100	10	--	Stationary	50	10	600	OHMSETT, Ixtoc 1
LPI Corporation	USA	Inclined Plane/Weir	--	10	25	6	--	200	3,600	--
Offshore Device Inc.	USA	Boom Skimmer	5,200	10	40	1	154	400	265	OHMSETT, Ixtoc 1
Oil Recovery International	England	Rope Mop Skimmer	2,300	14	30	4	1	50	190	Warren Spring Laboratory
Tracor Marine Inc.	USA	Suction/Weir	2,200	8	25	1.8	--	50	400	OHMSETT Ixtoc 1
T.R. Sillinger	France	Boom Skimmer	4,300	8	40	2.5	--	60	10.9	OHMSETT
Thune-Eureka	Norway	Disc	4,200	8	20	4	5	13	870	Amoco Cadiz

Notes: 1. Information obtained from the 1983 International Directory of Oil Spill Control Products published by Oil Spill Intelligence Report and Catalog of Oil Spill Booms and Skimmers, published by EPRCo.

2. See Table 2 for more information on skimmers.

3. Represents oil recovered during 10-hour day. USCG/MMS require minimum recovery to be 1,000 barrels per 10-hour day.

Appendix C

Table 7-2

Open Water Skimmer Evaluation

Skimmer	Skimming Width	Skimming Speed	Slick Thickness	Acceptance by Agency	Previous Performance
A/S DeSmithske (Destroil Skimmer)	10 ft. - not large enough for use as primary recovery skimmer for open ocean spills.	.75 kt - Too slow for use as advancing skimmer.	Not efficient for thin slicks.	--	Used during 7 spills since 1979. Performance data not available.
Frank Mohn (Weir/Disc Skimmer)	10 ft. - not large enough for use as primary recovery skimmer for open ocean spills.	Stationary - not intended for use as advancing skimmer.	Very good for thin slicks due to disc which collects oil.	--	Performed well at Ixtoc I-no problem during 90 days operation. Recovered 168 Bopd per unit.
LPI Corporation (Inclined Plane/Weir)	200 ft. - good for use as primary skimmer.	6 kt. self-propelled.	Large skimming width should thicken slick.	--	No performance or test data available.
Offshore Devices Inc. (Boom Skimmer)	400 ft. - Largest available - excellent for open ocean.	1 kt. - could be a problem for vessel of opportunity. But excellent as stationary skimmer down-stream of spill.	Large skimming width will collect and thicken thin slicks making recovery possible.	USCG/MMS	Good performance during rough weather at Ixtoc. Recovered 659 Bopd for 20 days. Removed from service due to pump failure. 30 systems currently owned by USCG. 2 owned by Clean Atlantic.
Oil Recovery International (Rope Mop Skimmer)	50 ft. - Adequate for small spills offshore.	4 kt. - very good for chasing oil slicks.	Estimated to have good recovery for slicks 1 mm thick.	--	No field performance data available.
Tracor Marine Inc. (Suction/Weir)	25 ft. - Adequate for small spills offshore.	1.8 kt. - Low speed could present problem for vessel of opportunity.	Good recovery performance for slicks 2 mm thick.	--	Operated for 55 days at Ixtoc at average recovery rate of 247 Bopd. Remove from service twice due to damage by rough seas.

Appendix C (Continued)

Table 7-2
Open Water Skimmer Evaluation

Skimmer	Skimming Width	Skimming Speed	Slick Thickness	Acceptance by Agency	Previous Performance
T.R. Sillinger (Boom Skimmer)	60 ft. - Adequate for small spills offshore.	2.5 kt. - required speed may not present problem for towing vessels. Speed greater than 1 knot may cause oil to escape boom.	Small skimming width may not sufficiently thicken thin slicks for recovery.	--	No field performance data available.
Thune Eureka (Disc Skimmer)	13 ft. - not large enough for use as primary recovery skimmer for open ocean spills.	4 knots - very good for chasing oil slicks.	Very good for thin slicks due to disc which collects oil.	--	Used during Amoco Cadiz spill - Data not available.

Appendix D

Table 7.3
FEDERAL/STATE REQUIREMENTS
for
OIL SPILL CONTINGENCY PLANS

CONTINGENCY PLAN SECTION	REQUIREMENTS	
	FEDERAL OIL POLLUTION REGULATIONS (OCS ORDER NO. 7 AND MMS GUIDELINES)	STATE OF ALASKA OIL POLLUTION REGULATIONS 18AAC20 and 18AAC75
Notification	1. Procedures for reporting oil spills. 2. List of key persons responsible for oil spill response. - names - telephone numbers - addresses 3. List of agencies that spill must be reported to: - names - telephone numbers - addresses	1. Procedures for reporting oil spills. 2. List of key persons responsible for oil spill response. - names - telephone numbers - addresses
Response	1. Identify predesignated oil spill response coordinator. 2. Identify provisions for responding to spills of various sizes.	1. Identify persons who are primarily responsible for oil spill containment and cleanup operations.
Response Equipment	1. Identify "state-of-the-art" equipment capable of operating in 8- to 10-foot seas and 20-knot winds, with deployment accomplished in the 5- to 6-foot sea range maintained at the offshore location or at a location approved by MMS.	1. In tabular form, list the amounts, specifications, limitations, and storage locations for oil spill cleanup equipment: A. direct control of operator B. indirect control of operator.

Appendix D (Continued)
Table 7.3
FEDERAL/STATE REQUIREMENTS
for
OIL SPILL CONTINGENCY PLANS

CONTINGENCY PLAN SECTION	REQUIREMENTS: FEDERAL OIL POLLUTION REGULATIONS (OCS ORDER NO. 7 AND MMS GUIDELINES)	REQUIREMENTS: STATE OF ALASKA OIL POLLUTION REGULATIONS 18AAC20 and 18AAC75
Response Equipment (Continued)	2. Identify provisions which assure that full resource capability is known and can be committed to recover at least 1,000 barrels of oil per day or an amount approved by MMS. 3. Identify vessels which will be used for spill response.	
Response Times	1. Operator should demonstrate some ability to initiate recovery operations with pre-staged equipment within 6-12 hours after a spill, or sooner if the Risk Analysis indicates that an oil spill will contact land in less than 6 hours. 2. For extraordinary spills, additional equipment should be on scene in 48 hours. 3. Vessel to deploy equipment should be available within stated response times. 4. Operator should have the capability to use dispersants within 24 hours after a spill.	1. Include best estimates of response times from discovery of discharge to deployment of equipment. 2. Identify resource which would be used to contain and clean up probable spills within 24 hours after occurrance if weather permits. 3. For spills threatening sensitive environmental zones and areas of public concern, discuss provision for preventing oil spill contact with the area closest to spill sources.
Response Considerations	1. Describe procedures that will be used to clean up an oil spill. 2. Identify provisions for detecting a spill and monitoring the movement of a slick.	1. Describe methods that will be used to respond to discharges of varying sizes, including the greatest possible discharge that could occur.

Appendix D (Continued)
Table 7.3
FEDERAL/STATE REQUIREMENTS
for
OIL SPILL CONTINGENCY PLANS

CONTINGENCY PLAN SECTION	REQUIREMENTS	
	FEDERAL OIL POLLUTION REGULATIONS (OCS ORDER NO. 7 AND MMS GUIDELINES)	STATE OF ALASKA OIL POLLUTION REGULATIONS 18AAC20 and 18AAC75
Response Considerations (Continued)	3. Person with authority to order well ignition. Include guidelines for well ignition decision and identify person with authority for making this decision. 4. Identify chemical agents and equipment. 5. Discuss methods and sites for the interim and ultimate disposal of recovered oil, oil-contaminated material, and other oily wastes.	2. Describe provisions for oil spill detection. 3. Identify provisions for emergency shutdown of the oil spill source. 4. Include procedures for using chemical agents. 5. Describe methods and sites for the interim and ultimate disposal of removed oil, oil-contaminated material, and other oily wastes. 6. Provide a relief-well plan including estimates of time to rig mobilization for commencement of drilling operation.
Communications	1. Identify location of oil spill response operations center. 2. Describe communications systems.	1. Provide an oil spill communications plan.
Training	1. Supervisory personnel must receive oil spill response training suitable for all seasons. 2. All members of oil spill response team must be familiar with the pollution-control equipment.	1. Describe the training program for oil spill response personnel.

Appendix D (Continued)
Table 7.3
FEDERAL/STATE REQUIREMENTS
for
OIL SPILL CONTINGENCY PLANS

CONTINGENCY PLAN SECTION	REQUIREMENTS	
	FEDERAL OIL POLLUTION REGULATIONS (OCS ORDER NO. 7 AND MMS GUIDELINES)	STATE OF ALASKA OIL POLLUTION REGULATIONS 18AAC20 and 18AAC75
Training (Continued)	3. Open water response drills for deploying equipment shall be conducted at least annually.	
Risk Analysis	1. Estimate the number and size of spills that could occur.	1. Include an estimate of the size, frequency, and location of the type of oil discharges which are most likely to occur.
Trajectory Analysis	1. Show where an oil spill is likely to flow under meteorological and oceanographic conditions which may occur.	1. Predict the movement and spreading for oil spills based on operational patterns and meteorological and oceanographic conditions.
Sensitivity Analysis	1. Include provisions for identifying and protecting areas of special biological sensitivity.	1. Identify sensitive environmental zones. 2. Identify areas of public concern.
Miscellaneous Provisions		1. Describe the drilling unit. 2. Provide a simplified oil spill response manual.

Appendix E

ALASKA'S OPEN BURNING LAWS

* * * * * * * * * * *

POLICY AND GUIDELINES

Control of open burning is the responsibility of the Department of Environmental Conservation. Open burning is defined in 18 AAC 50.900(31) as "the burning of a material which results in the products of combustion being emitted directly into the ambient air without passing through a stack or flare".

It is the policy of the Department of Environmental Conservation to eliminate, minimize, or control open burning and to encourage other methods of disposal where possible. When open burning is permitted by the Department, the permittee must provide for the most efficient combustion possible for the material to be burned. When the permittee is a government agency, consideration may be given to less efficient combustion when, in the judgment of the Department, it is in the public interest. The Department supports the maximum recycling and utilization of wood and forest products to reduce the volume of material requiring burning. The Department requires cooperation in its regulations from government agencies that use open burning as a management tool.

This booklet contains excerpts from the Alaska Air Quality Control Regulations, 18 AAC 50, as well as the required procedure for obtaining written approval from the Department.

18 AAC 50.030. OPEN BURNING. (a) Open burning must achieve maximum combustion efficiency throughout the burning period, and is subject to the exception in (e) of this section, the limitations in (b), (c), (d), and (f) of this section, and Section 18 AAC 50.110.

(b) Open burning of asphalts, rubber products, plastics, tars, oils, oily wastes, contaminated oil cleanup materials, or other materials in a way that gives off black smoke is prohibited without written approval from the Department. Approved open burning is subject to the following limitations:

(1) Controlled fires for training fire fighters must be advertised through news media in the general area of the activity at least three days before the activity, informing the public of the time, place, and purpose of the fire, unless waived by the Department.

(2) Open burning of liquid hydrocarbons produced during oil or gas well flow tests will be approved only if there are no practical means available to recycle, reuse, or dispose of the fluids in a more environmentally acceptable way.

(3) Reasonable procedures and requirements must be established by the person doing the burning to minimize adverse environmental effects and limit the amount of smoke generated.

(c) Open burning or incineration of pesticides, halogenated organic compounds, cyanic compounds, or polyurethane products in a way that gives off toxic or acidic gases or particulate matter is prohibited.

(d) Open burning of putrescible garbage, animal carcasses, or petroleum-based materials is prohibited if it causes odor or black smoke which has an adverse effect on nearby persons or residences.

(e) Controlled burning for the management of forest land, vegetative cover, fisheries, or wildlife habitat, other than burning to combat a natural wildfire, requires written approval from the department.

(f) Open burning is prohibited in an area if an air quality advisory by the Department is broadcast on radio or television stating that burning is not permitted in that area for that day. This advisory will be based on a determination that there is or is likely to be inadequate air ventilation to maintain the standards set by 18 AAC 50.020.

(g) Open burning is prohibited in wood smoke control areas identified in 18 AAC 50.021(d) between November 1 and March 31. (Eff. 5/26/72, Register 42, am 5/8/74, Register 50, am 5/4/80, Register 74, am 11/1/82, Register 84, am 10/30/83, Register 88)

Authority: AS 46.03.020(10)(A)
AS 46.03.140
AS 46.03.150

18 AAC 50.110. AIR POLLUTION PROHIBITED. No person may permit any emission which is injurious to human health or welfare, animal or plant life, or property, or which would unreasonably interfere with the enjoyment of life or property. (Eff. 5/26/72, Register 42)

Authority: AS 46.03.020(10)(A)
AS 46.03.140
AS 46.03.710

18 AAC 50.900. DEFINITIONS. In this chapter

(27) "maximum combustion efficiency" means, for open burning, that the following are attempted: material should be kept as dry as possible through cover or dry storage; noncombustibles are separated before burning; natural or artificially induced draft is included; combustibles are separated from grass or peat layer; and combustibles are not allowed to smolder;

(31) "open burning" means the burning of a material which results in the products of combustion being emitted directly into the ambient air without passing through a stack or flare;

(35) "practical means available" means, when approving the open burning of liquid hydrocarbons produced during oil or gas well testing, that all alternative disposal methods will have been analyzed, and where an environmentally acceptable procedure assists, it will be required;

(36) "putrescible garbage" means a material capable of being decomposed with sufficient rapidity to cause nuisance or obnoxious odors;

(41) "smolder" means to burn and smoke without flame;

APPENDIX E (Continued)

ALASKA AIR QUALITY PLAN

VOLUME II: ANALYSIS OF PROBLEMS, CONTROL ACTIONS

SECTION III. AREAWIDE POLLUTANT CONTROL EFFORTS

F. OPEN BURNING

Control of open burning incidences for smoke pollution is the responsibility of the Department. Open burning is defined as "the burning of a material which results in the products of combustion being emitted directly into the ambient air without passing through a stack or flare." All open burning in the state, whether requiring written approval from the Department or not, must be done in a way that maintains maximum combustion efficiency throughout the burning period. Achieving maximum combustion efficiency means the following are attempted:

- o material is dried through covering or storage;
- o noncombustibles are separated before burning;
- o combustibles are separated from grass layer or peat layer (a noncombustible firebreak is made to contain the fire); and
- o combustibles are not allowed to smolder (burn and smoke without flame).

Open burning is prohibited if the material burned is:

- o pesticides, halogenated organic compounds, cyanic compounds or polyurethane products burning in a way that gives off toxic or acidic gases or particulates; or
- o putrescible garbage, animal carcasses, or petroleum-based materials burned in a way that causes odor or black smoke to have an adverse effect on nearby persons or residences.

Open burning at landfills is also controlled by solid waste disposal regulations, 18 AAC 50.060.

Who needs written approval?

Certain types of open burning require written approval from the Department prior to the incident. These are the burning of

- o petroleum-based materials or other materials in a way that gives off black smoke, including fire fighter training;

APPENDIX E (Continued)

- o material from land-clearing operations for agricultural or development purposes of 40 acres or greater, based on the total amount of land to be cleared over the life of the project; or

- o material for the management of forest land, vegetative cover, fisheries, or wildlife habitat, except burning to combat a natural wildfire.

If human safety may be endangered, or to protect the environment (for example during an oil spill about to enter a watershed) verbal approval is adequate with a follow-up letter.

Approval application requirements

Persons seeking approval to open burn may be required to submit a plan addressing the following smoke control concerns:

1. Location and inclusive dates considered for fires, to the extent possible. The plan should state the expected duration the fire would be allowed or expected to burn.

2. The location of all sensitive population centers, ground travel routes, airport, or other activities that should not be impacted by smoke.

3. Where the weather forecasts will be obtained and how they will be used to prevent smoke problems.

4. How weather changes will be monitored and what will be done to reduce or mitigate smoke impacts if unfavorable weather should occur after ignition.

5. What the considerations are for visibility impacts.

6. How coordination with air quality authorities having jurisdiction will be accomplished.

7. The procedures that will be used to coordinate with other concerned agencies such as the FAA, State Troopers, military, adjacent land managers, etc.

8. How the public will be informed prior to, during, and after the burning.

9. What will be done within reason to reduce the duration of the active fire phase and smoldering phase.

10. What will be done to validate predicted smoke dispersal conditions such as a test fire, smoke bomb, etc.

APPENDIX E (Continued)

11. For fires other than for fire fighter training, an evaluation of alternatives to open burning is the only feasible alternative.

Persons with approved open burning plans should work directly with the National Weather Service Fire Weather Forecasters to obtain spot weather forecasts for expected smoke conditions at each specific burn site. The forecaster should be requested to give the reliability of the forecast. Persons with approval must curtail their fire if their portion of the airshed is becoming overloaded or local weather factors are creating smoke problems, even though no other restrictions have been imposed, i.e., wind moving directly into sensitive areas, inversions, etc. The final responsibility for smoke control problems rests with the applicant.

Open burning should be done as rapidly as safety and other considerations permit to develop maximum heat energy per unit time and vent the smoke to the highest elevation possible.

Burning of dried material is favored because:

- o higher heat energy with related tall connection columns can be developed;
- o cured material produces less smoke per unit volume than green material; and
- o the medium and heavy density fuels can be more effectively burned when cured, thereby removing the fire hazard more satisfactorily.

Approval Issuance

The following conditions as modified to fit the specific open burning situation may be included in the letter of approval:

- o The applicant may be required to obtain meteorological information for the burn day, specifically wind speed, wind direction and ceiling level, both for the start of the burn and forecasted for the duration of the burn. If the wind direction would allow smoke to impact on sensitive areas, burning may be denied for that period.
- o If the Department determines that the airshed is being overloaded with smoke, a termination of the existing and proposed burning may be required. Limitations may have to be placed on the burn for easy shutdown.
- o Notification at least one day in advance of burning should be provided to the department's regional office. If burning is not conducted for that day, re-notification is required on the day burning commences.

- A summary report listing types of fuels and quantities burned, days burning occurred, and the meteorological conditions during the burn should be sent to the Department.
- The approval letter must be sent out within thirty days after receipt of a completed application.
- The approval letter must have a date of expiration.

Open Burning Prohibition

Open burning can be prohibited on an area-by-area basis if an air quality advisory is broadcast on a radio or television covering the area of concern. This advisory can be for a maximum of twenty-four hours but may be renewed daily. The advisory will be based on an assessment that adequate air ventilation is unavailable (due to inversions and low wind speeds, for example) which would inhibit the dispersal of pollutants.

HERCULES LOAD PLANNER

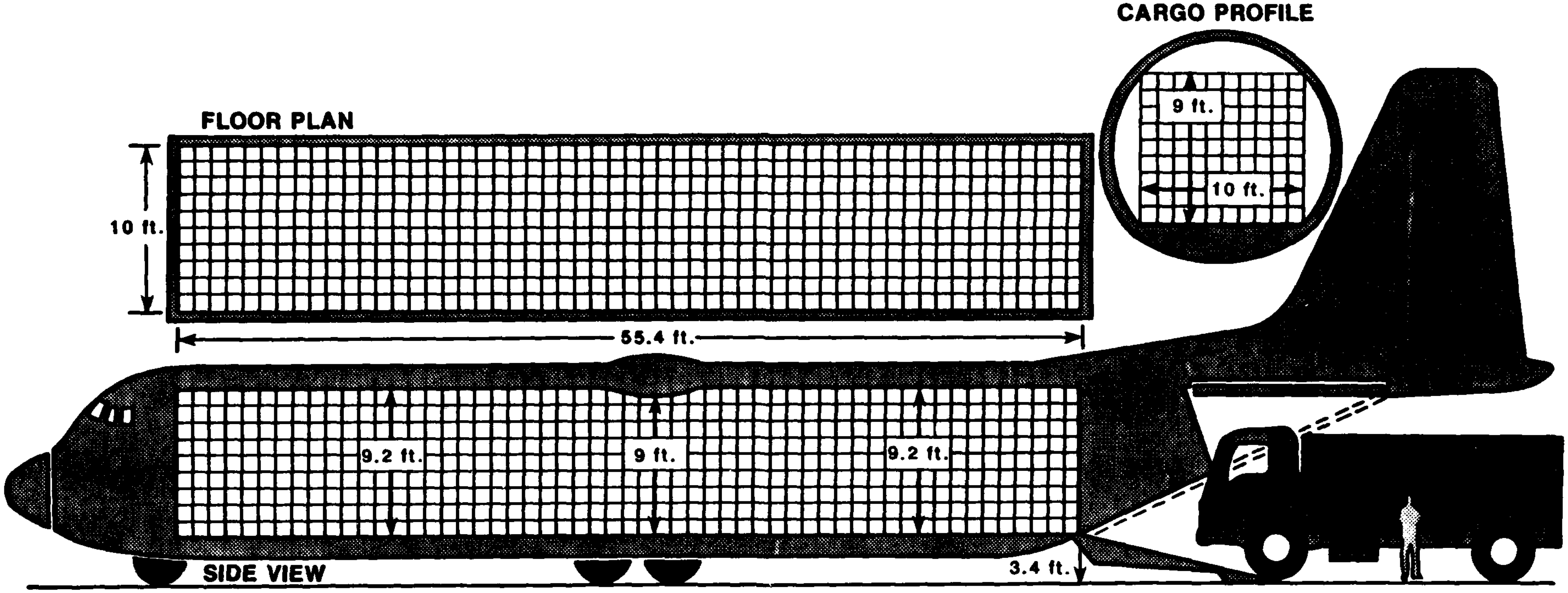


Figure 7.1.1

HERCULES L-100-30

Interior Dimensions

L-100-30		
CARGO HOLD:	**Feet**	**Meters**
Length	55.4	16.9
Height	9	2.74
Width	10	3.04
Cubic Capacity-Bulk	6,057	171.52
Cubic Capacity-Palletized	4,628	131.06
CARGO DOOR:		
Height	9	2.74
Width	10	3.04
Loading Deck Height	3.42	1.04
GROSS PAYLOAD*	**Lbs.**	**Kilos**
Maximum	50,500	22,907

* Gross payload includes tie down equipment and is subject to weather and stage length flown.

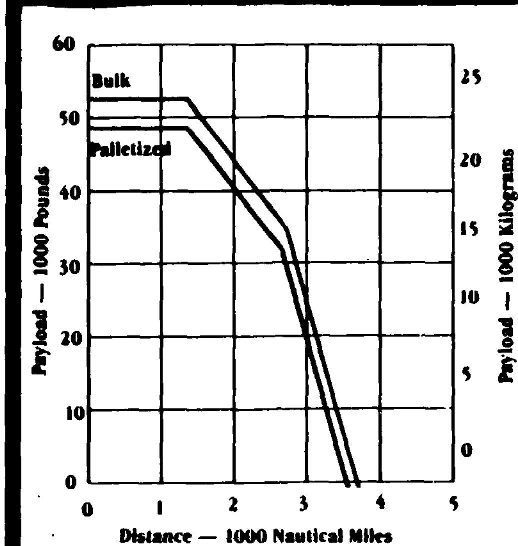
Airplane Characteristics

- Straight-in loading through aft-cargo ramp door
- Aft-cargo ramp adjustable to any position
- Truck bed height main floor
- Oversize cargo and heavy machinery transportation capability
- Integral winch and roller system for fast pallet and container loading
- Self-contained auxiliary power system

Cargo Accommodations

- Eight units — seven 88 x 118-inch (2.24 m x 3.00 m) pallets or containers, plus an 88 x 118-inch (2.24 m x 3.00 m) ramp container
- Mixes of 10, 20, 30 and 40 foot long (3.05 m, 6.10 m, 9.14 m, and 12.19 m) 8 ft. x 8 ft. (2.44 m x 2.44 m) cross section intermodal containers up to 54 feet (16.5 m) long
- Oversize shipments up to 54 feet long, 9.5 feet wide, and 8.5 feet high (16.5 m x 2.9 m x 2.6 m)
- Up to 6,057 cu. ft. (171.52 cu. m) cargo volume

Payload - Range*



* 200 Nautical miles plus 45 minutes fuel reserve, standard day, zero wind.

Operational Capabilities

- Simplified loading operations for quick turnarounds
- Direct loading from ground or truck
- Drive-on, drive-off vehicle loading
- Minimal ground support equipment
- Higher stack efficiency with full-height, rectangular-shaped loads

Airport Performance

- Efficient operation from unpaved fields in remote areas
- Safe operation from runways with low bearing capability
- Short field takeoff and landing performance

Payload - Runway Length

Take-off			
Runway Length		Payload	
Feet	Meters	Pounds	Kilograms
3,750	1,143	2,000	909
3,850	1,174	12,000	5,455
3,950	1,204	22,000	10,000
4,200	1,280	32,000	14,545
4,300	1,311	42,000	19,091
4,500	1,372	47,000	21,364

- Empty aircraft weight 76,000 pounds
- Standard Day, no wind, no slope

Landing			
Runway Length		Payload	
Feet	Meters	Pounds	Kilograms
3,750	1,143	47,000	21,364

Notes and Calculations

Figure 7.1.2

DATA ON HERCULES L-100-30

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9.0 DEFINITIONS

Abandoned River Channel: a river channel not experiencing through flow; however, flow may occur during periods of high runoff.

Algae: any of a group of aquatic nonvascular plants with chlorophyll (often masked by brown or red pigment); example: seaweeds, pond scums.

Alluvial Deposits: materials deposited by a stream or running water.

Alluvial Fan: a fan-shaped deposit of alluvium made by a stream where it runs onto a horizontal plain.

Amphipod: any of a large group of small crustaceans with a laterally compressed body; example: sand flea.

Application for Permit to Drill (APD): a document submitted by lease operators for review and approval by the MMS. This application includes operational plans for detailed casing, mud, and cementing programs for a well.

Aquifer: a water-bearing bed or stratum of earth, gravel, or porous stone.

Assessment: determining the volume and extent of an oil spill and predicting its probable movement.

Barrow Ditch (borrow ditch): the drainage ditch along one or both sides of a road.

Bathymetry: the measurement of water depth.

Bend: a curve in a stream or river.

Benthic: living on or in the bottom of a body of water.

Berm: an earth barrier constructed to contain or divert the flow of oil.

Biomass: the amount of living matter in an area.

Blowout: an uncontrolled flow of gas, oil, or other fluids from a well. A well can blowout when formation pressure exceeds pressure applied to it by a column of drilling fluid.

Blowout Preventor (BOP): a stack or assembly of heavy-duty valves attached to the top of a well casing to control pressure.

Bog: a waterlogged, spongy groundmass containing decaying vegetation (peat).

Boom: a floating barrier used to control oil on water.

Borehole: a hole drilled in the earth's crust in an effort to locate oil or gas.

Braided Stream: a stream or river that branches and rejoins repeatedly to form a network of channels separated by islands or bars.

Breakup: the period when ice cover on streams and rivers break; a period of high runoff and water flow.

Bryozoan: any of a phylum of aquatic, mostly marine invertebrate animals that reproduce by budding and usually form permanently attached branched or mossy colonies.

Caisson: a single-leg platform.

Casing: steel pipe used in wells to seal off fluids in the rocks from the borehole and to prevent the walls of the hole from sloughing off or caving.

Channel: a defined route for surface water flow.

Cleanup: the process of removing spilled oil and oil-contaminated material.

Coastal Waters: the waters surrounding the continent which exert a measurable influence on uses of the land.

Condensate: a natural gas liquid consisting primarily of pentanes and the heavier hydrocarbons.

Confluence: the point at which two or more streams join and flow together.

Containment: the process or steps taken to stop the spread of an oil spill.

Containment Pit: a natural or excavated depression suitable for holding spilled oil or oiled debris.

Containment Site (CS): designated specific location where oil or oiled debris may be contained.

Contingency Plan: a plan for possible offshore emergencies prepared and submitted by an oil or gas operator as part of the plan for exploration, development, or production.

Copepod: any of a large subclass of usually minute freshwater and marine crustaceans.

Crude Oil: A mixture of hydrocarbons that is in the liquid phase in natural underground reservoirs and remains liquid at atmospheric pressure.

Crustacean: any of a large class of mostly aquatic arthropods that have an exoskeleton, a pair of appendages on each segment, and two pairs of antennae; example: lobster, shrimp, crab.

Demersal: bottom-dwelling, used of aquatic organisms (as fishes).

Desiccation: drying up; especially the effects on organisms in the intertidal zone as they are exposed to air during low tide.

Detection: determining or finding that an oil spill has occurred.

Development: activities that occur after the discovery of quantities of petroleum products.

Development and Production Plan: a plan required under 30 CFR 250.34 describing the facilities and specific work to be performed, including all development or production that a lessee proposes to undertake during the time period covered by the plan.

Diatom: any of a class of minute planktonic unicellular or colonial algae with silicified skeletons that form diatomite.

Dinoflagellates: any of an order to planktonic forms important in aquatic food chains and including forms causing red tides; usually solitary plant-like flagellates.

Dispersant: a chemical agent used to disperse oil spilled on water.

Diversion Booming: employing boom or booms to divert spilled oil from its path of movement.

Diversion Ditch: an excavated ditch for directing the flow of oil to containment areas or away from sensitive areas.

Drainage Basin: the area drained by a stream or river.

Drainage Course: the route followed by surface runoff or streams.

Drill Pipe: Heavy, thick-walled steel pipe used in rotary drilling to turn the drill bit and to provide a conduit for the drilling mud.

Drill Ship: a self-propelled, self-contained vessel equipped with a derrick amidships for drilling wells in deep water.

Drilling Mud: a special mixture of clay, water, or refined oil, and chemical additives pumped down hole through a drill pipe and drill bit.

Drogue: a sea anchor used in boom deployment.

Enclosure Booming: deploying booms to completely close off an area.

Entrain: to draw in and carry with the current flow.

Ephemeral Stream: a stream that does not always flow water.

Epibenthic: living on the sea bottom, usually below low-water mark.

Flagellate: a unicellular organism - protozoan or algae - with elongated filiform appendages, usually used as organs of motion.

Floodplain: the relatively flat land adjacent to a river channel that is covered with water when the river overflows its banks.

Fossil Fuel: a naturally occurring fuel of organic nature. Examples are crude oil, natural gas, and coal.

Fuel: any substance that can be burned to produce heat. Sometimes includes materials that can be fissioned in a chain reaction to produce heat.

Gravel Island: a foundation area constructed of gravel from which to drill exploratory wells. Gravel islands are used mainly in the Arctic, where the presence of moving ice could cause damage to conventional platforms.

Haulout Areas: Locations where native Alaskans bring marine mammals ashore for subsistence.

Hydraulic Erosion: the processes by which water breaks up earth or rock.

Hydroblasting: using a high-powered stream of water to remove oil.

Hydrocarbon: any of a large class of organic compounds containing primarily carbon and hydrogen.

Immediate Response Actions: actions that must be taken as soon as a spill is detected.

Impermeable: material not permitting water (or oil) to move through it.

Intertidal Zone: the shore zone between high and low tide levels; synonym: littoral.

Isobath: a line on a marine map or chart that connects points of equal depth below a water surface.

Inversion: atmospheric conditions where temperature increases with altitude and holds pollutants close to the ground.

Leachate: the liquid that has percolated through soil or another medium.

Lighter (v): to convey by a lighter

Lighter (n): large flat-bottomed barged used especially in unloading or loading ships.

Marsh: a water-saturated area with poor drainage.

Material Sites: designated site where materials for constructing berms and dams may be obtained.

Meander: a loop-like bend in a stream or river.

Oil Spill Cooperatives: groups of companies who have pooled their resources for oil spill control and cleanup.

Oleophilic Material: a substance which attracts oil.

Pallet: predesignated equipment assembled for transport.

Permafrost: permanently frozen soil.

Permeable: material through which water (or oil) will pass.

Phytoplankton: the passively flowing, minute plant life of a body of water.

Reconnaissance: actions to visually locate a potential or known spill.

Restoration: the process of restoring an affected area to prespill conditions.

Runoff: surface discharge of water into rivers, streams, and other drainage features.

Skimmers: devices for removing oil from the surface of water.

Sorbent: material which absorbs oil or to which oil adheres.

Sorbent Boom: a boom composed of sorbent material.

Substratum (substrate): the base on which an organism lives.

Surface Tension Modifier: chemicals used to control oil spills on water by altering surface tension.

Thermal Erosion: the process which occurs when the insulation layer over permafrost is compacted or removed, allowing thaw to extend to an abnormal depth and collapsing the soil structure.

Trafficability: a measure of the capacity of a surface to support traffic.

Tributary: any stream that contributes water to another stream.

Weir: a barrier allowing water to pass over it.

Well (Exploratory or Development): A hole drilled for the purpose of finding or producing crude oil or natural gas. The term includes wells classified as oil wells, gas wells, or dry holes.

Wildcat: an exploratory well drilled in unproven territory; i.e., into a horizon from which there has been no production in the general area.

Wind Chill Factor: an equivalent still-air temperature that would have the same cooling effect on exposed human flesh as a given combination of temperature and wind speed.

Windrow: a long, narrow band of oil or oil emulsion on water, formed by wind or water action.

Zooplankton: minute animal life on or in a body of water.

CONVERSION EQUIVALENTS AND USEFUL FACTS

1 barrel of crude oil weighs about 295 pounds. One gallon of crude oil weighs 7.034 pounds.

1 acre = 43,560 square feet.

1 hectare = 10,000 square meters = 2.471 acres, or 107,638 square feet.

1 square mile = 640 acres.

1 U.S. gallon = 0.833 Imperial gallons.

1 Imperial gallon = 1.2 U.S. gallons.

The average Federal Offshore track is approximately 9 square miles.

1 statute mile = 5,280 feet.

1 nautical mile = 6,076 feet = 1,852 meters = 1.1508 statute miles.

3 nautical miles = 1 marine league = 3.45 statute miles.

60 nautical miles = 1 degree of a great circle of the earth.

6 feet = 1 fathom = 1.829 meters.

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